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ABSTRACT

Presented is a collection of abstracts of selected technical reports, journal articles, and other documents resulting from research supported by the directorates of the National Science Foundation. Reports are grouped by sponsoring directorate: Biological, Behavioral and Social Sciences; Engineering; and Scientific, Technological and Industrial Affairs. Also included is a group of abstracts dealing with research publications from previously supported programs. Information for ordering NSF research reports and journal articles is provided. Also included are three appendices: UTS Briefs, NISEE price list, and NSF organization chart. (EB)

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RECENT RESEARCH REPORTS

NATIONAL SCIENCE FOUNDATION WASHINGTON, D.C.

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INTRODUCTION

This report contains abstracts of selected technical reports, journal articles, and other documents resulting from research supported by the directorates of the National Science Foundation. These citations have been compiled to alert members of the scientific and engineering community to current research results.

The National Science Foundation is an agency of the Federal Government established in 1950 to promote and advance scientific progress in the United States. The Foundation fulfills this responsibility primarily by sponsoring scientific research and by encouraging and supporting improvements in science education.

On March 8, 1981, The National Science Foundation was reorganized to broaden the agency's capacity to support basic and applied research in the sciences and engineering and to give new emphasis to engineering research. Appendix C depicts the new organization to the division level.

A major change was the establishment of a Directorate for Engineering to include the Divisions of Electrical, Computer and Systems Engineering; Chemical and Process Engineering; Civil and Environmental Engineering; and Mechanical Engineering and Applied Mechanics.

NSF's applied research programs and personnel in the former Directorate for Engineering and Applied Science were distributed among four directorates: Engineering; Biological, Behavioral and Social Sciences; Astronomical, Atmospheric, Earth and Ocean Sciences; and Mathematical and Physical Sciences.*

In addition, the Division of Information Science and Technology was transferred to the Biological, Behavioral and Social Sciences Directorate. The Directorate for Scientific, Technological, and International Affairs now includes two new divisions, the Division of Intergovernmental and Public Service Programs and the Division of Industrial Science and Technological Innovation, both transferred from the former Engineering and Applied Science Directorate.

The Foundation carries out its statutory responsibilities for the support of research, including applied research, through a number of programs. The Foundation's Guide to Programs; Grants for Scientific Research; and other brochures or announcements containing information about NSF programs are available from: Publications, National Science Foundation, Washington, D.C. 20550

Requests for information regarding specific NSF technical publications may be addressed to: NSF Communications Program, Office of Planning and Resources Management, National Science Foundation, Washington, D.C. 20550.

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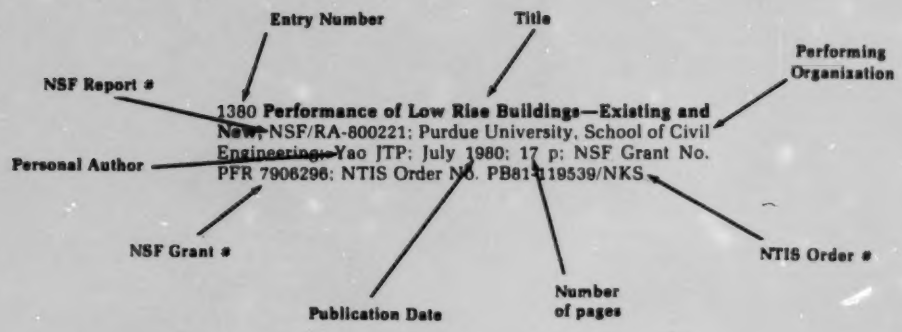
* Proposals for applied research should be submitted to the directorate under which the research would properly fall.

Organization of Citations in Recent Research Reports

Each citation is presented in a standard form illustrated below:


Entry Number
Title
Performing Organization
NSF Report #
1380 Performance of Low Rise Buildings—Existing and New; NSF/RA-800221; Purdue University, School of Civil Engineering; Yao JTP; July 1980; 17 p; NSF Grant No. PFR 7906296; NTIS Order No. PB81-119539/NKS
Personal Author
NSF Grant #
NTIS Order #
Publication Date
Number of pages

Abstract

An evaluation of the safety-related seismic performance of existing low-rise building structures is described. The theory of structure reliability is reviewed and error and defect related failures for new constructions are assessed. Failures related to wearout and deterioration also are discussed. Estimation of structural reliability requires determination of the configuration, material, and type of construction. The behavior of an existing completed structure may not correspond to the mathematical model used prior to construction. For certain important structures, nondestructive tests are performed to collect selected load and response data. Techniques of system identification then are applied to obtain a more selective mathematical model for further analysis. An existing structure can be tested either periodically or immediately following an extreme event. Literature relating to new construction failure is reviewed. The need for a set of standard nondestructive testing and inspection techniques is discussed.

Citations are arranged in broad subject categories. Entry numbers are assigned consecutively beginning with the first issue of Recent Research Reports, published in October 1976. Indexes following the main body provide access by subject, performing organization, NSF report number, contract/grant number, and author, and refer to the entry number of the document.

Information on NSF scientific and engineering technical publications may be obtained by writing to:

Ms. Carmeen Adams
NSF Communications Program
Office of Planning and Resources Management (OPRM)
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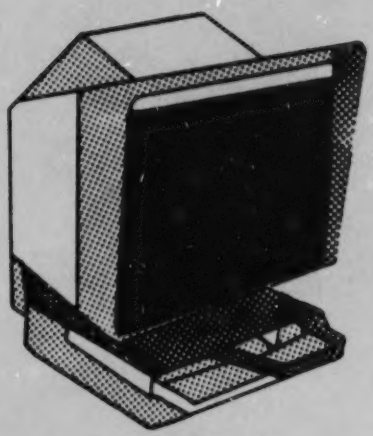
NSF Research Documents on Microfiche



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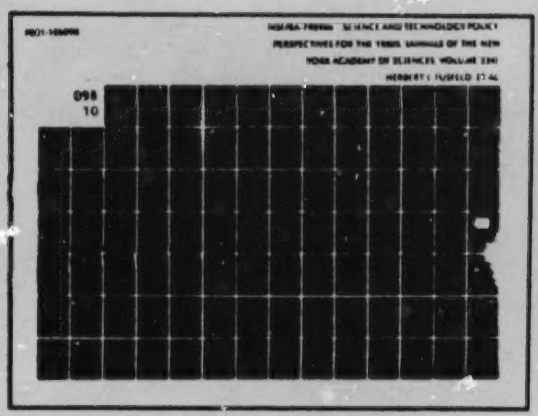

Microfiche (actual size 4" x 6")

Many documents resulting from NSF-supported research can be obtained in microfiche form from the National Technical Information Service (NTIS) or in some cases from the NSF Communications Program.

As many as 98 printed pages can be photographically reduced to fit on a single 4" x 6" sheet of film which contains multiple images in a grid pattern. Documents that cost up to $40 in paper copy are available for less than $4 per microfiche, and microfiche storage requires only a fraction of the space needed to house hard copy documents. For example, 150 sheets of microfiche are only one inch thick.

Portable fiche readers, some less than book size and very lightweight, are readily available in most libraries and R & D facilities. Machines to print either photographic or xerographic full size reproductions of microfiche documents are also available.

Inquiries concerning microfiche may be made directly to:

George James, Program Manager
NSF Communications Program
Office of Planning and Resources Management (OPRM)
National Science Foundation
Washington, D.C. 20550

How to Order NSF Research Reports

All documents cited in **Recent Research Reports** may be ordered from the sources noted.

Many of these documents may be ordered from the National Technical Information Service (NTIS), Document Sales, U.S. Department of Commerce, Springfield, Virginia 22161. Please refer to the NTIS order number. NTIS document pricing information may be obtained by utilizing the following formula:

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76-100	9.50	376-400	27.50
101-125	11.00	401-425	29.00
126-150	12.50	426-450	30.50
151-175	14.00	451-475	32.00
176-200	15.50	476-500	33.50
201-225	17.00	501-525	35.00
226-250	18.50	526-550	36.50
251-275	20.00	551-575	38.00
276-300	21.50	576-600*	39.50

For information on foreign prices, call (703) 487-4785. Microfiche is available at a cost of $3.50 per document.

*For reports of 601 or more pages, add $1.50 for each additional 25-page increment. Prices are subject to change.

How To Order Journal Articles

Journal articles can be ordered from either the cited journal or the author. They can also be ordered using the DIALOG Online Ordering Service from the Engineering Societies Library (ESL) or from the Institute for Scientific Information (ISI) for articles from 1978 to the present. Written and telephone requests for copies of articles are also accepted.

Prices for ESL are as follows: $.30 per page plus $4.00 (written request) or $5.00 (online order) handling per item, including first class mail. For details on ESL ordering information contact:

Mrs. Carol Tschudi
Engineering Societies Library
345 East 47th Street
New York, NY 10017
(212) 644-7610

Prices for ISI are as follows: An article of 20 or fewer pages costs $5.50, including first class mail delivery in the U.S., Mexico, and Canada. For every additional ten pages there is a $2.00 charge per article. For details on ISI ordering information contact:

Ms. Diane Sewell
Supervisor, OATS Department
Institute for Scientific Information
3501 Market Street
University City Science Center
Philadelphia, PA 19104
(215) 386-0100

DIRECTORATE FOR BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES (BBS)

Publications Cited

Division of Environmental Biology (DEB)

Amino Acid Composition of Grain Protein of Maize from Matched Pairs of Organic and Conventional Fields, **J.L. Wolfson and G. Shearer** 5
Commercial Organic Farming in the Corn Belt in Comparison to Conventional Practices, **W. Lockeretz and S. Wernick** 5
Commercial-Scale Organic Farming in the Corn Belt in Relation to Conventional Practices and Alternative Agricultural Systems (Some Organic Farmers Do Not Appear to Fit Some Widely Held Stereotypes), **W. Lockeretz and S. Wernick** 5
Crop and Livestock Production on Beef and Hog Producing Midwestern Organic Farms: 1977 and 1978, **G. Shearer, D.H. Kohl, W. Lockeretz, et. al.** 5
Maize Yields and Soil Nutrient Levels With and Without Pesticides and Standard Commercial Fertilizers, **W. Lockeretz, G. Shearer, D. Wanner, et al.** 6
Results of a Study of Resource Conserving Agricultural Methods: A Brief Report, Final Report, **D.H. Kohl and G. Shearer** 6

Division of Information Science and Technology (IST)

Database Searching and Document Delivery Via Communications Satellite, Final Report, **R.G. Lerner, C.K. Mick, and D. Callahan** 7
Information and Work: Research on the Improvement of Practitioner Information Systems, **W. Paisley and A. Hardy** 7
Levels of Output Related to Cost of Operation of Scientific and Technical Libraries: Final Report of the LORCOST Libraries Project, Volume 1, **P.B. Kantor*** 7
Levels of Output Related to Cost of Operation of Scientific and Technical Libraries: Final Report of the LORCOST Libraries Project, Volume 2, Appendices, **P.B. Kantor*** 7
Levels of Output Related to Cost of Operation of Scientific and Technical Libraries: Final Report of the LORCOST Libraries Project, Volume 3, **P.B. Kantor*** 7
Manual of Procedures for Conducting Telephone Hearings in Unemployment Insurance Administrative Appeals, **J.R. Corsi** 7
Report on an Experiment with an Electronic Conferencing System within a Scientific Community, Final Report (October 1, 1977-March 31, 1980), **J. P. Martino and J. Bregenzer** 8

Division of Physiology, Cellular and Molecular Biology (PCM)

Bioconversion of Biomass Gasifier Product Gases to Organic Chemicals, Final Report (November 1, 1978-April 13, 1980), **P.F. Levy, G.W. Barnard, S.P. Evangelos, et al.** 9
Breeding Improvement of Rubber Yield in Guayule, Sixth Progress Report, **G.P. Hanson** 9

Division of Social and Economic Sciences (SES)

Costs and Benefits of Government Regulations on Ground Beef Products (Economic and Legal Analysis of the Benefit-Cost Relationship of Federal, State, and Local Regulations Concerning the Production and Sale of Ground Beef, Volume 1, Phase 2), **T. Hu, C. Chang, R. Crandall, et al.** 10
The Impact of Regulations on Technological Change in the Production and Distribution of Ground Beef (Economic and Legal Analysis of the Benefit-Cost Relationships of Federal, State, and Local Regulations Concerning the Production and Sale of Ground Beef, Volume 2, Phase 2), **I. Feller, J. Sink, C. Paden, et al.** 10
Recent Research on Fiscal Limitation Measures, A Selective Survey, **J. N. Danziger and P.S. Ring** 10

*Principal Investigator for this NSF supported research project—no individual report author listed.

DIRECTORATE FOR BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES

Division of Environmental Biology

1320 **Amino Acid Composition of Grain Protein of Maize from Matched Pairs of Organic and Conventional Fields;** NSF/RA-790674; Washington University, Center for the Biology of Natural Systems; Wolfson JL, Shearer G; 1979; 15 p; NSF Grant No. AER 7717031; NTIS Order No. PB81-210502/NKS

Measurements are reported of the amino acid composition of protein from maize (Zea mays L.) grain raised on fourteen pairs of organic and conventional fields which were matched for location, cultivar, planting date, and soil type. The amino acid composition of the organically raised maize grain was superior with respect to concentrations of lysin and methionine, two essential amino acids which are in low concentration in maize. However, because of higher protein yields in conventionally grown grain, amino acid yields per unit area were significantly higher in grain from the conventional fields, except for methionine, for which there was no significant difference. Differences in yield, protein concentration, and amino acid composition between organic and conventional maize were similar in direction, although not necessarily in magnitude, to reported differences between nitrogen-fertilized and non-nitrogen-fertilized maize. At least part of the difference between organic and conventional maize is consistent with a greater accumulation of zein in conventionally raised maize grain. Results presented in this paper suggest that organic maize yields could be increased by modest applications of nitrogen.

1321 **Commercial Organic Farming in the Corn Belt in Comparison to Conventional Practices;** NSF/RA-790661; Washington University, Center for the Biology of Natural Systems; Lockeretz W, Wernick S; August 1979; NSF Grant No. AER 7717031; NTIS Order No. PB81-204398/NKS

Samples of farmers in the western Corn Belt who use organic methods to raise field crops on a commercial scale were studied using mailed questionnaires, interviews, and field measurements. Data reported were tabulated for the 363 respondents whose farms met the following criteria: at least 100 acres total size; field crop production the main crop enterprise; at most, occasional light use of synthetic herbicides on the land they considered organic; no use of inorganic nitrogen fertilizer or urea, superphosphate, muriate of potash, or synthetic insecticides on land considered organic; and organic methods used on at least half of the farm. Their motivations, practices, and performance were compared with "organic" and "conventional" idealized types as depicted in popular media. Although organic farmers do not use the pesticides and fertilizers that have become increasingly important since the 1940s, in other respects their farms are similar to the majority of farms of the 1960s or 1970s. They show little evidence of the metaphysical or philosophical outlook often associated with organic farming.

1322 **Commercial-Scale Organic Farming in the Corn Belt in Relation to Conventional Practices and Alternative Agricultural Systems (Some Organic Farmers Do Not Appear to Fit Some Widely Held Stereotypes)** NSF/RA-790672; Washington University, Center for the Biology of Natural Systems; Lockeretz W, Wernick S; August 1979; 30 p; NSF Grant No. AER 7717031; NTIS Order No. PB81-206195/NKS

In this study one type of organic farmer was compared to various images of farmers. It was found that the stereotypes were inaccurate. This type of organic farmer operates on a commercial scale, and in most cases, once farmed using conventional methods. They do not consist primarily of "back-to-the-land" refugees from the city, or old and old-fashioned farmers, or Amish. While ideological and religious motives play a role in their decision to use organic methods, practical considerations such as their health and the quality of their soils are far more important to them. The main practices used by these farmers are rotations, manure applications, and cultivation, all of which are also used to a considerable degree on conventional farms, especially mixed crop-livestock operations. Except for the application of low-analysis commercial organic fertilizers, organic farmers rarely use methods that conventional farmers would regard as exotic. Both in their purchase of inputs and in the channels they use to sell their products, these farmers are involved in the larger economic system. In both size and labor intensiveness, the differences between the organic farms and their conventional counterparts are ones of degree, not qualitative differences.

1323 **Crop and Livestock Production on Beef and Hog Producing Midwestern Organic Farms: 1977 and 1978;** NSF/RA-790673; Washington University, Center for the Biology of Natural Systems; Shearer G, Kohl DH, Lockeretz W, et al; 1979; 38 p; NSF Grant No. AER 7717031; NTIS Order No. PB81-206419/NKS

The sample of organic farms for this study was drawn from a survey which identified over 250 farmers in the western Corn Belt who do not use standard commercial fertilizers of pesticides and who primarily produce field crops, generally in association with livestock, on farms of over 40 hectares in size. The study sample was limited to beef and hog producing farms in Iowa, southern Minnesota, and northern Illinois which had been soil mapped. Wherever possible, organic farms were compared to all beef and hog farms in each of the counties in which the organic farms were located. Less land was used for corn and more for oats on organic beef and hog farms than on similar farms in the counties. The market value of crops produced per unit area of cropland on the county beef and hog farms was higher than on organic farms, but the difference was much smaller in the poor growing season of 1977 than in the superior growing season of 1978. Operating expenses

for crop production were lower on organic farms than on county farms, mostly due to differences in expenditures for fertilizers and pesticides. Energy use per dollar value of crops produced was considerably lower on organic farms.

1324 **Maize Yields and Soil Nutrient Levels With and Without Pesticides and Standard Commercial Fertilizers;** NSF/RA-790668; Washington University, Center for the Biology of Natural Systems; Lockeretz W, Shearer G, Wanner D, et al; 1979; 28 p; NSF Grant No. AER 7418438; AER 7717031; NTIS Order No. PB81-206179/NKS

This paper reports maize (Zea mays L.) yields on two groups each of 26 commercial mixed grain and livestock farms covering a wide range of soil types in the western Corn Belt. One group was managed with conventional fertilization and pest control practices, while no herbicides, insecticides, or standard commercial fertilizers were used on the other. The mean yield from the conventional fields was 8.5 percent higher than from the matched fields on which typical fertilizers or pesticides were not used. The difference was not statistically significant. Conventional maize yields tended to be higher than maize yields on fields which received no pesticides or fertilizers under favorable growing conditions and lower when conditions were adverse. Grain from the fields receiving pesticides and fertilizers had a significantly higher crude protein content. These fields also had a significantly higher incidence of Diplodia stalk rot and lodging. Soils from fields receiving no pesticides and fertilizers had a significantly higher organic carbon content, as well as higher total nitrogen, but lower P1 phosphorus. Differences in P2 phosphorus, exchangeable potassium, carbon:nitrogen ratio, cation exchange capacity and pH were not significant.

1325 **Results of a Study of Resource Conserving Agricultural Methods: A Brief Report, Final Report;** NSF/RA-800508; Washington University, Center for the Biology of Natural Systems; Kohl DH, Shearer G; February 1980; 15 p; NSF Grant No. AER 7717031; NTIS Order No. PB81-206203/NKS

This research consisted of three components: a comparison of organic and conventional farms in the Midwest; sewage sludge application on Midwest cropland; and irrigation in the Great Plains. To study the effect on productivity and farm income of reducing agricultural chemical use, two extremes were compared on a continuum of chemical intensiveness in agricultural production: present conventional practice and organic practice in which the use of chemicals is reduced to zero. Agricultural production in the Great Plains is dependent on irrigation. This type of agriculture is vulnerable to water shortages caused either by aquifer depletion or by insufficiency of energy needed to pump the water. The effects of either type of shortage are strongly dependent on certain site-specific variables. A method was developed for calculating site-specific effects of diminishing ground water reserves on irrigated agriculture. This method was applied to several sites in Plains states. The ground water and energy supply situation in four Plains states were surveyed.

DIRECTORATE FOR BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES

Division of Information Science and Technology

1326 **Database Searching and Document Delivery via Communications Satellite, Final Report;** NSF/DSI-800005; American Institute of Physics; Applied Communication Research, Inc.; Lerner RG, Mick CK, Callahan D; June 1980; 84 p; NSF Grant No. DSI 7718052; NTIS Order No. PB81-153314/NKS

An alternative format for publishing and distributing research information, other than the traditional printed journal was investigated. A new combination of existing technologies provided an efficient means of identifying journal articles of interest to individuals, and delivering copies of single articles immediately. The demand for copies of articles prior to journal publication was also investigated. Librarians, scientists, and engineers at several laboratories associated with NASA used an online information system, DIALOG, to search SPIN, a computerized database of physics and astronomy articles. Requested articles were delivered by facsimile transmitter. A data base of abstracts of articles accepted for publication but not yet in print was also available. Searches and document delivery used either the experimental Communications Technology Satellite (CTS) or telephone lines. An ATS satellite was occasionally used for document delivery. The technologies tested were found to be viable. Facsimiles were acceptable, although the quality of graphics and mathematics was somewhat lower than the original material. The response time of the system to requests for information was excellent. Demand for manuscripts in advance of publication was lower than expected.

1327 **Information and Work: Research on the Improvement of Practitioner Information Systems, Final Report, October 1978-March 1980;** NSF/IST-800005; Stanford University, Institute for Communication Research; Paisley W, Hardy A; October 1980; 125 p; NSF Grant No. IST 7726242; NTIS Order No. PB81-136038/NKS

Problems related to the implementation and use of practitioner information systems are outlined. Considered are the background and information attitudes that practitioners bring to the tasks, and the information environment in which the tasks are performed. This project adopted a task-performance model of practitioners' work. It defined the primary tasks that practitioners' information-related work consists of and located task performance within a social framework in which information use is affected by work teams, employing organizations, and formal and informal professional groups. A state-of-the-art practitioner information system, WESTFORNET (Western Forest Information Network), was the focus of data collection in this project. WESTFORNET is used by managers, forestry professionals, engineers, applied scientists, and others working in decentralized and often remote U.S. Forest Service work sites. Information attitudes and behaviors were analyzed primarily by practitioners' job categories. Additional analyses explored mode-of-practice differences and functional rather than structural descriptions of practice specialties.

1328 **Levels of Output Related to Cost of Operation of Scientific and Technical Libraries: Final Report of the LORCOST Libraries Project, Volume 1;** NSF/DSI-800002; Case Western Reserve University, Case Institute of Technology; Kantor PB, Principal Investigator; 1980; 110 p; NSF Grant No. DSI 7717776; NTIS Order No. PB81-124703/NKS

A two-year study explored the possibility of gathering quantitative data on the service rendered by scientific and technical libraries, integrating it into mathematical models of the cost-benefit relation, and providing a base for estimation of national levels of activity. Libraries were shown to obey a family of general laws, with economy of scale. Estimates were found of the relative cost of various types of services. The analysis is based upon data collected at and by 73 participating libraries, selected from a national frame of 5,000 libraries. Detailed formulas, plots, and tables are presented. Several related topics in the availability of reference service and the pricing of library services were examined also.

1329 **Levels of Output Related to Cost of Operation of Scientific and Technical Libraries: Final Report of the LORCOST Libraries Project, Volume 2, Appendices;** NSF/DSI-800003; Case Western Reserve University, Case Institute of Technology; Kantor PB, Principal Investigator; 1980; 66 p; NSF Grant No. DSI 7717776; NTIS Order No. PB81-124711/NKS

See entry 1328 for abstract.

1330 **Levels of Output Related to Cost of Operation of Scientific and Technical Libraries: Final Report of the LORCOST Libraries Project, Volume 3;** NSF/DSI-800004; Case Western Reserve University, Case Institute of Technology; Kantor PB, Principal Investigator; 1980; 192 p; NSF Grant No. DSI 7717776; NTIS Order No. PB81-124729/NKS

See entry 1328 for abstract.

1331 **Manual of Procedures for Conducting Telephone Hearings in Unemployment Insurance Administrative Appeals;** NSF/RA-800185; University of Denver, Department of Political Science; Corsi JR; June 1979; 97 p; NSF Grant No. DAR 7715516; NTIS Order No. PB81-111775/NKS

Appeals hearings as conducted by the New Mexico Department of Human Services were examined. The procedures established by the California Unemployment Insurance Appeals Board to utilize telephone hearings as a substitute both for the interstate split hearing process and for interstate simultaneous divided hearings were also investigated. This manual relies heavily upon procedures designed to conduct telephone hearings in New Mexico and California. Examples are provided so that any state agency may adapt these experiences to its own particular circumstances. The study reveals that telephone hearings do meet

the minimum due process standards as specified by the courts and that telephone hearings can be successfully scheduled and conducted. The telephone hearing is an example of available communications technology which can be applied to a legal/governmental process.

1332 **Report on an Experiment with an Electronic Conferencing System within a Scientific Community, Final Report (October, 1977—March 31, 1980)**; NSF/DSI-800006; University of Dayton, Research Institute; Martino JP, Bregenzer J; June 1980; 40 p; NSF Grant No. DSI 7717920; NTIS Order No. PB81-102634/NKS

This report describes an operational trial with the Electronic Information Exchange System (EIES). It was utilized by scientists in the Futures Research community, from October 1977 through March 1980. This report describes both initial expectations for use and the actual use observed during the course of the experiment. Reasons for the deviation of actual use from expected use are presented. The report also presents some statistics on various types of uses to which the system was put.

DIRECTORATE FOR BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES

Division of Physiology, Cellular & Molecular Biology

1333 **Bioconversion of Biomass Gasifier Product Gases to Organic Chemicals, Final Report (November 1, 1978—April 13, 1980)** NSF/RA-800117; Dynatech R/D Company; Levy PF, Barnard GW, Evangelos SP, et al; April 1980; 105 p; NSF Grant No. PFR 7816404; NTIS Order No. PB80-216641/NKS

A simple and efficient high-pressure culturing technique was developed as a means of selecting bacterial populations that could use gaseous substrates. A number of bacterial cultures were selected on the basis of their ability to use either carbon monoxide/hydrogen (CO/H_2) or carbon dioxide/hydrogen (CO_2/H_2). Further selection and enrichment of gas-utilizing cultures were pursued in experiments conducted in high-pressure culture vessels capable of containing pressures up to five atmospheres, in serum bottles and Hungate tubes at pressures up to three atmospheres, and in continuously fed fermenters at atmospheric pressure. Cultures have been successfully developed from mixed bacterial sources that utilize CO_2/H_2. The primary liquid product is acetic acid, which is formed from carbon contained in the feed gas. Other organic acids (propionic, butyric, valeric) have been detected in the cultures, but the carbon source for these acids has not been conclusively shown to be the feed gas.

1334 **Breeding Improvement of Rubber Yield in Guayule, Sixth Progress Report;** NSF/RA-800118; California Arboretum Foundation; Hanson GP; June 1980; 211 p; NSF Grant No. AER 7624472; NTIS Order No. PB81-110405/NKS

Summarized are recent studies in the breeding improvements of rubber yield in guayule. Breeders working for the Emergency Rubber Project developed a number of cultivars from which seed was preserved and stored by USDA. These activars, augmented by new collections from Texas and Mexico, serve as the germ plasm base for recent breeding programs. Topics covered in this report include: breeding for high rubber yield and improved adaptation in guayule; observation on the distribution and ecology of native guayule populations in Mexico; harvesting and cleaning of bulk guayule seed; guayule propagation and growth under greenhouse conditions; interspecific hybridization; selection for high rubber yield in guayule; isozyme variations in Parthenium and their inheritance during guayule interspecific hybridization; evaluating resistance in verticillium wilt disease in species of Parthenium; Phytophthora root rot disease and other pests of guayule culture; distribution of rubber and comparative stem anatomy of high and low rubber guayule from Mexico; and growth studies of cultivated guayule.

DIRECTORATE FOR BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES

Division of Social and Economic Sciences

1335 **Costs and Benefits of Government Regulations on Ground Beef Products (Economic and Legal Analysis of the Benefit-Cost Relationships of Federal, State, and Local Regulations Concerning the Production and Sale of Ground Beef, Volume I, Phase 2);** NSF/RA-800129; Pennsylvania State University, Institute for Policy Research and Evaluation; Hu T, Chang C, Crandall R; et al; May 1980; 187 p; NSF Grant No. DAR 7719341; NTIS Order No. PB80-221807/NKS

This study assesses whether various governmental regulations of ground beef products are in the public interest. The investigation examined six aspects: (1) social costs of the government meat inspection program (with special reference to ground beef); (2) social costs of beef import quotas (with special reference to ground beef); (3) cumulative effects of government regulations on ground beef products; (4) consumer demand for regulations toward the product quality of ground beef; (5) benefits and costs comparison of ground beef regulation on labeling and product quality; and (6) distributional effects of government regulations on product labeling and product standard with respect to ground beef products. Results indicate that certain regulations, such as product quality and labeling enforced by the Wholesome Meat Act, are in the public interest. However, the Meat Import Act and government regulation of voluntary import quotas are contrary to consumer welfare. Other regulations such as OSHA and effluent emissions, play a relatively minor role in the cumulative costs of regulations on ground beef products.

1336 **The Impact of Regulations on Technological Change in the Production and Distribution of Ground Beef (Economic and Legal Analysis of the Benefit-Cost Relationships of Federal, State, and Local Regulations Concerning the Production and Sale of Ground Beef, Volume II, Phase 2);** NSF/RA-800130; Pennsylvania State University, Institute for Policy Research and Evaluation; Feller I, Sink J, Paden C, et al; May 1980; 221 p; NSF Grant No. DAR 7719341; NTIS Order No. PB80-224009/NKS

This study assesses the impact of regulatory standards in the production and distribution of ground beef on the rate and direction of technological change in related industry segments. A literature review was conducted and alternate frameworks for analyzing the impacts of regulation on technological change are outlined. The investigation focused on three general questions concerning the relationships between regulations and technological change: (1) level of technological activity in an industry; (2) characteristics of innovation that are developed within an industry; and (3) length of time between the rate at which an innovation can be held to be commercially useful and the time at which it is commercially introduced. Different measures of technology are presented and employed to answer these questions. An alternative "best practice" approach to the analysis of technological change is described. The study indicates that the various approaches provide insights into different aspects of the impact of regulations on technological change.

1337 **Recent Research on Fiscal Limitation Measures, A Selective Survey;** NSF/RA-800131; University of California at Irvine, Public Policy Research Organization, Danziger JN, Ring PS; 1980; 66 p; NSF Grant No. DAR 7824567; NTIS Order No. PB80-210677/NKS

The causes and consequences of California's passage of Proposition 13 are reviewed through an examination of recent literature. Knowledge gained from the study is used to form tentative conclusions concerning ways of improving government fiscal policy. This report is divided into five sections: (1) classification of alternate types of policy instruments that attempt to operate as fiscal constraints on governments; (2) examination of recent literature regarding causes of the fiscal limitations movement in general, and Proposition 13 in particular; (3) a study of the effects, focusing on what scholars and researchers have suggested, of the immediate and most likely outcomes of Proposition 13; (4) tentative conclusions about who appear to be the winners and losers from measures aiming to lower taxes, limit government spending, and produce more "efficient" government; and (5) an outline of an agenda for research on fiscal limitations measures, indicating areas for continued activities. Included is a table showing the rank-ordering of importance of conducting research on selected issues related to fiscal limitations measures.

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1338 **Agenda for Small Farms Research: Report on Phase II of the NRC Small Farms Project;** NSF/RA-800087; Pennsylvania State University, College of Agriculture; Madden JP, Tischbein H, West JG; April 1980; 205 p; NSF Grant No. OPA 7815342; NTIS Order No. PB80-226202/NKS

Literature on small-farms research is reviewed, and topics meriting further research are evaluated. These include values; production efficiency and technology; marketing; energy; tax policies; prices, income and credit policies; off-farm income; and structure of agriculture. A summary of the findings of the literature-review papers is presented, including the state of knowledge on issues essential to enlightened public policy and the well-being of small-scale farm families and rural communities. Findings reveal several types of deficiencies in existing literature, notably, simplistic definitions, obsolete research technology and prices, chronic information gaps, and lack of validation needed to predict the success or failure of small-farm businesses or of programs intended to help farms service and prosper. An agenda for further research is suggested to fill critical gaps found in the existing research literature.

1339 **National Recycling Research Agenda Project: Final Report;** NSF/RA-800137; Institute for Local Self-Reliance, Inc.; Seldman NN; March 1980; 128 p; NSF Grant No. OPA 7917013; NTIS Order No. PB81-103814/NKS

The project was convened in order to address the requirements of a Federal R&D investment program which would encourage a diversified approach to a wide array of material and energy recovery technologies, allowing local governments, private enterprise, and citizens to reap the full potential from its solid waste management institutions. In order to identify qualified experts, a conference announcement was released in September 1979 through a network of recycling organizations. Over 150 individuals who responded to the announcements were asked to provide resumes and to address nine problem areas relating to resource recovery technology development. These nine areas were determined by project staff in consultation with over 60 individual practitioners in the fields of source reduction, source separation recycling, and small scale energy recovery. They are as follows: markets for secondary materials; compatibility of recycling (materials recovery) and combustion (energy recovery); technology and equipment development; project initiation; waste (source) reduction; participation; institutional barriers; hazardous waste; and waste utilization. Project staff selected 111 qualified participants to attend two working conferences held in San Francisco and Washington, D.C. The final research agenda which was developed is presented and includes subtopics for the main research areas as well as recommendations for research, an implementing agency, and a budget.

1340 **Research Agenda on Science and Technology for the Handicapped (Workshop Proceedings, November 26-28, 1978);** NSF/RA-790484; American Association for the Advancement of Science; Brown JW, Redden MR; January 1979; 61 p; NSF Grant No. OPA 7825354; NTIS Order No. PB80-212913/NKS

This workshop was designed to develop an agenda to support NSF staff in planning a program of research in science and technology for the handicapped, as mandated by Congress. A major goal was to involve handicapped scientists and engineers in the planning process. An overview presentation describes the scope of the proposed agenda stressing that it include the full range of disability groups. Also discussed are the establishment of regional centers to address individual needs, philosophical differences within disability groups, and research priorities. Seven science and technology categories were highlighted: mobility impairment--neuromuscular/skeletal disabilities; visual disability; hearing impairment; vocal impairment; psychological and social issues for research; economic issues for research; and principles for operating an R & D program for the physically handicapped.

1341 **Research in Great Plains Drought Management Strategies, Proceedings of the Workshop (Lincoln, Nebraska, March 26-28, 1979);** NSF/RA-800068; University of Nebraska, Institute of Agriculture and Natural Resources; Rosenberg N J, Hoffman R O, Quinn M L, et al; February 1980; 256 p; NSF Grant No. OPA 7721289; NTIS Order No. PB80-200975/NKS

Current knowledge of past and present effects of Great Plains drought was reviewed in each of four task groups and major areas where knowledge is lacking were identified and reported. The future vulnerability of the Great Plains region to drought was assessed. All task groups recognized the inevitability and the climatic normality of drought in the Great Plains region. It was generally agreed that physical vulnerability of the land is now increasing because of excessive use of fossil water and because of inappropriate land use in marginal areas. The economic (and, therefore, political and social) vulnerability will likely increase since the Great Plains region's intensive agriculture, already strained by extreme and rapid increases in the costs of energy, can be shocked even more in times of drought. Many of the obvious drought defenses, such as irrigation and rough tillage, are heavy consumers of energy. Drought mitigation strategies for the Great Plains, applicable on the local, state, regional, and national scales, are suggested.

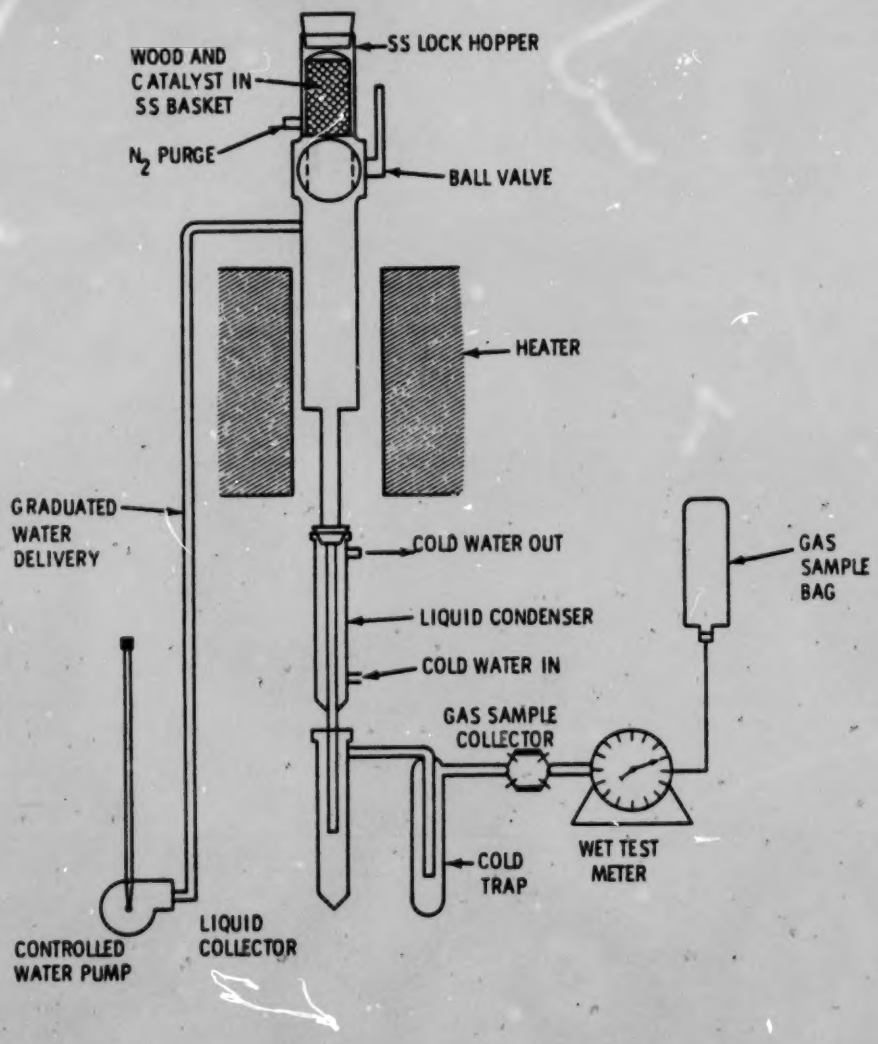

FIGURE 1. Ball Valve Batch Reactor

See Entry 1344

DIRECTORATE FOR ENGINEERING

Division of Chemical and Process Engineering

1342 **Amplification of Sound by Gas-Phase Reactions, Final Technical Report, December 1, 1978-January 31, 1980;** NSF/RA-800057; University of Mississippi, Department of Physics and Astronomy; Bass H E; March 1980; 33 p; NSF Grant No. ENG 7818078; NTIS Order No. PB80-201155/NKS

This report describes an experimental investigation of sound amplification in a reacting gas mixture. The system chosen for study is the chlorine/hydrogen photoinitiated reaction involving four sequential chemical reactions. Initially, a sound pulse passes down a cylindrical sound tube in which the reaction has been started by a UV flash. The resulting flash increases pressure due to dissociation of chlorine and heating from subsequent exothermic reactions. Increased pressure in the illuminated part of the tube expands the gas moving towards both non-illuminated ends. Upon reaching the microphone, the expanded gas pressure suddenly increases, and this pressure wave is reflected from the microphone. Positive pressure pulse is followed by a decrease in pressure. Microphone output is recorded on FM tape for analysis and photography. The most serious problem encountered is the limited dynamic range of the microphones. The photoinitiated reaction provides the energy and mechanism for the observed amplification. Measured gain is L-8 at 2kHz compared to a gain of 4 predicted by theory. Results indicate that gas-phase amplification of sound appears to be experimentally feasible.

1343 **Biological and Synthetic Systems for Production of Hydrogen from Water, Final Report (June 1, 1975—March 31, 1980);** NSF/RA-800064; Columbia University, College of Physicians and Surgeons; Krasna A I; March 1980; 20 p; NSF Grant No. PFR 7408381; NTIS Order No. PB80-200942/NKS

The laboratory feasibility of producing hydrogen by biophotolysis of water is demonstrated. One method uses intact hydrogenase-containing algae capable of yielding large quantities of hydrogen in the presence of oxygen-removing agents. Reversible and irreversible oxygen absorbents have been developed to solve the problem of oxygen inhibition. Continuous methods for oxygen removal permit sustained large-scale production of hydrogen. Another biophotolysis scheme uses isolated plant chloroplasts coupled to hydrogenase or synthetic catalysts, with ferredoxin or methyl viologen as an electron carrier. Light acts on water to produce hydrogen in the presence of oxygen-removing systems. The anaerobic reduction of the electron carrier by chloroplasts is the limiting factor in the process. Platinum and palladium catalysts can effectively replace hydrogenase in this coupled system. A number of synthetic systems have been developed to produce hydrogen from organic compounds in the presence of light and various photocatalysts. These methods constitute a non-polluting, alternate technology to produce hydrogen for fuel and as a chemical feedstock for fertilizer production.

1344 **Biosources Digest, A Journal of Biomass Utilization, Volume 2, Number 1, January 1980;** NSF/RA-800060; NEUS, Inc.; Sobel H, Editor; January 1980; 74 p; NSF Grant No. PFR 7712500; NTIS Order No. PB80-209364/NKS

At a recent meeting of the staff of Biosources Digest and the Board of Directors of NEUS, Inc., the International Association for Biomass Utilization (IABU) was organized. IABU intends to serve the future needs of a growing population by searching for and studying new products derived from biomaterials which include renewable sources of nutrients, materials, chemicals, and energy. IABU will operate as an independent, non-profit division of NEUS, Inc. In this issue, current research in biotechnology in Turkey is summarized. Grant awards are listed by title, author, and institution, together with abstracts. Publications received are itemized, as are pertinent patents and a schedule of forthcoming meetings. Five technical articles are presented: "Kinetics and Mechanisms of Steam Gasification of Biomass in the Presence of Alkali Carbonates," "A Low Investment Approach to Alcohol Fermentation," "Sheldon-Arleta Landfill Gas Recovery Facility," "Strip-Mined Land Revegetation Using Municipal Sludge," and "Bioconversion of Plant Residues into Chemicals: Production of Chemicals from Lignin."

1345 **Biosources Digest, A Journal on Biomass Utilization, Volume 2, Number 2, April 1980;** NSF/RA-800084; NEUS, Inc.; Sobel H, Editor; April 1980; 81 p; NSF Grant No. PFR 7712500; NTIS Order No. PB80-210214/NKS

In this issue, an editorial emphasizes the determinant role of technology and economics in selecting energy-rich materials. It also announces plans to hold a NATO Advanced Study Institute on biomass utilization and to establish an International Association for Biomass Utilization (IABU). The following technical papers are presented: "Thermochemical Conversion Activities Funded by the Biomass Energy Systems Branch, U.S. Dept. of Energy," "A Microbial Route for Acrylic Acid Production," "The Supply of Douglas Fir and its Potential for Biomass Utilization," "California's Program Converts Biomass Residues to Energy," "Opportunities and Plans for a Biosolar Economy in Brazil, and its Challenge to the Developed World," and "Testimony on Alcohol Fuels." Grant awards are listed by title, award number, principal investigator, institution, and project description. A section on recent publications includes the name of the publication, author, and price. Pertinent patents are listed by number, title, and inventor. A page of miscellany announces a course in fermentation technology, engineering fellow-

ships, funding for alcohol fuels, and information on gasohol. Forthcoming professional meetings are listed.

1346 **Chemical and Process Engineering, National Science Foundation Program Report, Volume 4, Number 4, May 1980;** NSF/RA-800171; National Science Foundation. Directorate for Engineering and Applied Science; Atkinson RC, Lih MM, Hand JH, et al; May 1980; 36 p; NTIS Order No. PB80-218795/NKS

This issue is devoted to NSF's Chemical and Process Engineering Division of the Engineering and Applied Science (EAS) Directorate. The Division comprises chemical processes, engineering energetics, thermodynamics and mass transfer, and particulates and multiphase processes programs. Described are the organization, scope of projects, accomplishments, cooperative projects, and budget of the division. Four individual projects are highlighted: (1) kinetics of bubble nucleation from superheated nonideal liquid mixtures; (2) dynamic effects of surfactants on interfacial viscoelastic properties; (3) supported metal and cluster catalysis; and (4) immobilization of enzymes. Other significant research accomplishments of the Division described briefly include: high gradient magnetic separation; plasma-induced polymerization; catalytic methylation of aromatic compounds using carbon monoxide and water; development of a highly efficient membrane reactor; and development of a novel filtration method for separating fine particles from nonaqueous colloidal suspension by attracting the particles to a central electrode using a high voltage gradient.

1347 **Chemicals from Western Hardwoods and Agricultural Residues, Appendix Volume, Semiannual Report;** NSF/RA-800069; University of Washington. College of Forest Resources; Sarkanen K V; April 1980; 117 p; NSF Grant No. PFR 7706979; NTIS Order No. PB80-201403/NKS

Papers on the following topics include: the associative effects among organosolv lignin components; the effect of heating and quenching rates on volatiles produced from combustion-level-heat-flux pyrolysis of biomass; and the effect of particle size on volatiles produced from plasma pyrolysis of lignin. Organosolv lignins isolated under relatively mild conditions from angiosperms are composed of entities having low molecular weights. The extent to which an individual component may participate in association depends appreciably upon the relative proportions of the other species present. A simple conduction model is used to adequately predict the devolatilization rate of lignin pellets. The data reported has application to processes in which densified biomass is a fuel or feedstock and the heat transfer rate appears to limit the reaction rate. Models of biomass pyrolysis presented in the literature are reviewed for effect of particle size on product distribution. Compressed lignin pellets of varying sizes are pyrolyzed in a microwave plasma, and char and volatile yields are reported as functions of particle size. Chemical analyses of noncondensible and condensible volatiles are presented, and possible formation mechanisms are discussed.

1348 **Chemicals from Wood by Organic Solvent Delignification, Interim Report;** NSF/RA-800159; University of Alabama. College of Engineering; April GC, Hansen SM, Sheng J, et al; July 1980; 97 p; NSF Grant No. AER 7802851; NTIS Order No. PB80-216617/NKS

This report reviews the experimental application of organic solvent pulping technology to obtain chemicals from southern woods. Batch delignification studies are presented of Southern Yellow Pine (soft wood) and Sweet Gum (hard wood) using aqueous n-butanol, enthanol, and phenol solutions at temperatures between 135°C and 205°C. Temperature, catalyst type and concentration, wood type, and treatment method are some of the variables that were tested. Results from Southern Yellow Pine pretreatment studies using water are reported and rates of hemicellulose and ß-cellulose hydrolysis are determined and compared with organosolv treatment results. The use of semi-batch pulping methods to more clearly elucidate rate behavior and solvent selectivity is noted. Also presented is a kinetic analysis of batch and semi-batch results. Both delignification and pulp loss are described by first order reaction kinetics, results generally agreeing with those reported in the literature. Bulk delignification reaction rates for the first step of the process are faster than those for the second step. General trends for both steps agree with previously established values for similar wood types and solvents.

1349 **Degradation of ^{14}C-Labeled Lignins and ^{14}C-Labeled Aromatic Acids by Fusarium solani;** NSF/RA-800369; University of Wisconsin, Russell Laboratories; Norris DM; 1980; 5 p; NSF Grant No. PFR 7708279

Abilities of isolate AF-W1 of Fusarium solani to degrade the side chain and the ring structure of synthetic dehydrogenative polymerizates, aromatic acids, or lignin in sound wood were investigated under several conditions of growth substrate or basal medium and pH. Significant transformations of lignins occurred in 50 days in both unextracted and extracted sound wood substrates with 3 percent malt as the growth substrate and the pH buffered initially at 4.0 with 2,2-dimethylsuccinate. Degradation of lignin in such woods also occurred under unbuffered pH conditions when a basal medium of either 3 percent malt or powdered cellulose in deionized water was present. Decomposition of the lignin in these woods did not occur in cultures where D-glucose was present as a growth substrate.

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F. solani significantly transformed (as evolved $^{14}CO_2$) both synthetic side chain (beta, gamma)- ^{14}C- and U-ring- ^{14}C-labeled lignins in 30 days under liquid culture conditions of distilled deionized water and no pH adjustment. Degradation of dehydrogenative polymerizates by F. solani was reduced dramatically when D_2 was the liquid medium.

Note: Published in Applied and Environmental Microbiology, Volume 40, Number 2, August 1980, pp. 376-380.

1350 **Enzymatic Transformations of Lignin, Final Report of the Research Project (July 1, 1978—June 30, 1979);** NSF/RA-790365; Virginia Polytechnic Institute and State University, Departments of Chemical Engineering, Forest Products, and Chemistry; Drew S W, Glasser W G, Hall P L; November 1979; 150 p; NSF Grant No. AER 7611050; NTIS Order No. PB80-173966/NKS

Research activities are reported for an interdisciplinary project which examines biological approaches to the utilization of lignin. The study explores the microbiology and embryology of lignin biodegradation, identifies and characterizes enzymes involved in the degradation of lignin, and assesses the feasibility of transforming polymeric lignin preparations via microbiological and/or enzymatic means into useful raw materials for the manufacture of chemicals and materials. These studies aim to create new knowledge in microbiology, enzymology, microbiological engineering, and chemical wood technology. The report focuses on three research areas: (1) biomedical engineering with respect to fermentation parameters, multistage lignin fermentations, and assay of lignolytic efficiency; (2) wood chemistry studies on selection and preparation of lignin samples, with an analysis technique including NMR spectroscopy; and (3) enzymology as related to lignolytic enzymes, lignin-protein associative interactions and hypotheses.

1351 **Experimental Macroalgal Mariculture, Quarterly Report (January 1, 1980—March 31, 1980);** NSF/RA-8000065; Neushul Mariculture, Inc.; Neushul M; 27 p; NSF Grant No. PFR 7911715; NTIS Order No. PB80-201882/NKS

Progress in the development of methods for the commercial cultivation of marine macroalgae is reported. Attention is focused on those species of algae having the highest present potential for commercial use. Increased understanding of the life cycles of algae has stimulated research in commercial seaweed farming to produce algae on a large scale. This experimental project was conducted in the coastal waters off southern California. The research procedures used were those normally employed at an agricultural experiment station: documenting environmental conditions; designing and building farm structures; collecting, propagating, weighing, growing, culling, and analyzing various plants; and performing field-test experiments. The study analyzed problems of providing seed-stock, substratum, and nutrients to a shallow-water marine farm. Marine farm structures were designed using a plastic, agricultural irrigation pipe which acts as a planting substratum and vehicle for nutrient irrigation. Results point out the importance of the geographic placement of farm installations, of the environmental conditions, and of farm structure design. Valuable algae have been grown successfully at relatively high growth rates.

1352 **Fluidization and Fluid-Particle Systems Research Needs and Priorities (Proceedings of the NSF Workshop Held at Rensselaer Polytechnic Institute, Troy, New York, October 17-19, 1979);** NSF/RA-800149; Rensselaer Polytechnic Institute, Department of Chemical Engineering and Environmental Engineering; Littman H; October 1979; 650 p; NSF Grant No. ENG 7825928; NTIS Order No. PB80-207640/NKS

The workshop brought together researchers in fluidization and fluid-particle systems from industry, government, and academic institutions to discuss research needs and priorities. Participants reviewed the many large and small scale fluidized bed processes presently in use and/or under development and studied their applications to energy and the environment. They also reviewed fluid-particle systems such as those used in pneumatic transport, standpipe flow, and spouting. Much attention focused on a presentation of large-scale facilities and scaleup since phenomena such as bubble size, size distribution, and particle circulation are scale-dependent. The need for large-scale research facilities was noted. The fact was raised that dynamic models for fluidized beds are non-existent, as is the case for spouted beds, and other fluid-particle systems. Also discussed were equations of motion, stability, heat and mass transfer, chemical reaction, elutriation, attrition, mechanics in the distributor plate and freeboard regions of fluidized beds, effects of electric and magnetic fields, and the turbulent fluidization of large particles.

1353 **Heat Transfer Characteristics of the Two-Phase Closed Thermosyphon (Wickless Heat Pipe) Including Direct Flow Observation, Final Report;** NSF/RA-800392; Arizona State University; Andros FE, Florschuetz LW; April 1980; 387 p; NSF Grant No. ENG 7509072; NTIS Order No. PB80-203540/NKS

In Part I a visual study of an annular two-phase closed thermosyphon (wickless heat pipe) is reported. The heat transfer surface was stainless steel. Working fluids were Freon-113, ethanol, and water. Photographs of pertinent phenomena are included. The visual observations were used to interpret the measured heat transfer characteristics. For small and intermediate

liquid fill quantities four flow regimes were observed in the evaporation section, in addition to nucleate boiling in the liquid pool: (1) a smooth continuous film with surface evaporation; (2) breakdown of the film into stable rivulets; (3) a wavy film with unstable rivulets; and (4) a wavy film with bubble nucleation in the unstable rivulets. Three different types of 'dry-out' conditions (heat transfer limits) were also observed and are reported in detail. In Part II results obtained for a stainless steel tubular opaque device with Freon-113 as a working fluid are reported. This device was designed to permit a larger range of geometric configurations (heated length, adiabatic length, cooled length, and angle of inclination). Both steady rate heat transfer characteristics and heat transfer limits are reported in detail. In Part III, results from the visual and opaque devices are compared and discussed. The present results are compared with those of other investigations, and conclusions and recommendations are drawn.

1354 **Integrated Approach to the Conversion of Lignocellulose from Wood into Useful Chemicals, Summary Report: Preliminary Process Design;** NSF/RA-800063; North Carolina State University, Department of Wood and Paper Science; Goldstein I S; April 1980; 33 p; NSF Grant No. PFR 7712243; NTS Order No. PB80-201031/NKS

An integrated process for the hydrolysis of wood using super-concentrated hydrochloric acid is described. The process has been simulated using the General Energy and Material Balance System (GEMS) computer system to examine the preliminary process design and to perform process analysis calculations. These computer-assisted calculations enable easy and rapid evaluation of process operating variables and economic sensitivity analysis. A process flowsheet depicts an integrated hydrochloric acid wood hydrolysis plant that processes 1,100 oven-dry-tons per day, producing furfural, acetic acid, ethanol, and lignin residue. Plant economics studies estimate a capital investment of $94 million, annual operating expenses of $35 million, revenues of $75 million, and an after-tax return on investment of 16 percent. The effect on the process of changing acid recovery efficiency has been examined. Co-product credits are crucial to the economic feasibility of the integrated wood chemicals plant.

1355 **Laminar Film Flow Phenomena-Theory and Application to the Two-Phase Closed Thermosyphon, Final Report;** NSF/RA-800393; Arizona State University, Engineering Research Center; Hirshburg RT, Florschuetz LW; May 1980; 344 p; NSF Grant No. ENG 7509072; NTIS Order No. PB80-205156/NKS

In Part I the hydrodynamic and thermal characteristics of thin, laminar wavy-film flow are considered. A theoretical model is developed to predict the hydrodynamic features of asymptotic wavy-flow states. The mathematical closure question arising in asymptotic-state analyses is satisfactorily resolved here for the first time. The model accurately predicts published experimental data for mean film thickness, trough-to-crest dimension, wave celerity, and wavelength. The Nusselt theory for laminar film condensation is shown to significantly under-predict existing experimental data due to the presence of waves on the condensate film surface. Consequently, a heat transfer model is developed incorporating the wavy-film hydrodynamic model results. The subsequent predictions agree well with experimental data and, in addition, indicate the appropriate data trend with flow length. In Part II other thin film phenomena are described, including continuous-film breakdown, rivulet flow, and sputtering. All of these phenomena are present in the operation of a heat transfer device known as the two-phase closed thermosyphon (wickless heat pipe). This device was experimentally investigated. Parameters of investigation include the tube material, working fluid, fill quantity, heat flux, condenser/adiabatic/evaporator section lengths, condenser temperature, and tube inclination.

1356 **Lignocellulose-Degrading Bacteria, Progress Report;** NSF/RA-800158; University of Minnesota, Gray Freshwater Biological Institute; Crawford RL; July 1980; 37 p; NSF Grant No. PFR 7906772; NTIS Order No. PB81-103533/NKS

The preparation of strains of Streptomyces viridosporous (T7A) and their ability to degrade lignin were studied. An effective method for producing lignin degrading streptomycete strains was developed. Mutants of strain T7A that had lost their ability to degrade the lignin model compound dehydrovanillin were produced. Since these mutants retained undiminished ability to degrade ^{14}C-lignin, dehydrovanillin apparently is not a relevant model to study lignin degradation by S. viridosporous. Lignin that has been partially decayed by S. viridosporous has been characterized as follows: (1) increased oxygen content compared to sound lignin; (2) increased hydrogen; (3) decreased methoxy content; (4) increased p-hydroxyphenyl-carbon structures; and (5) a still polymeric structure. These observations point to oxidative degradation similar to that occurring during the fungal decay of lignin.

1357 **Low Temperature Thermoconversion of Biomass to Useful Chemicals by Lewis Acid Catalysts, Final Report, Phase I (October 1, 1979—March 31, 1980);** NSF/RA-800067; EIC Corporation; Koch V R, Schnaper G H; March 1980; 28 p; NSF Grant No. PFR 7917513; NTIS Order No. PB80-200462/NKS

Lewis acids such as aluminum chloride ($AlCl_3$) were used for thermoconversion of lignocellulosic materials (biomass) into useful organic materials. Temperatures used

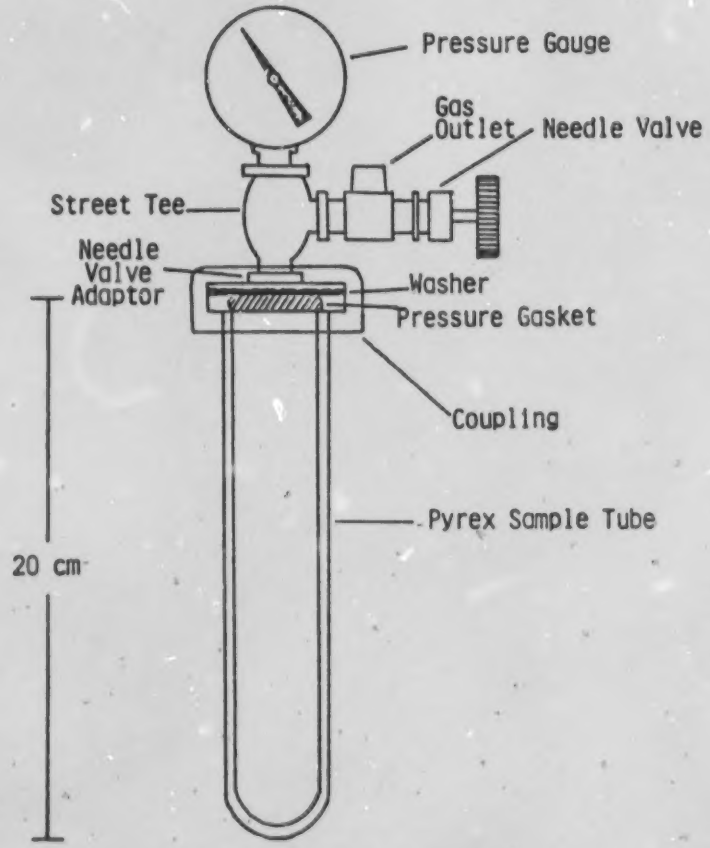

Fig. 2: Reactor Assembly.

See Entry 1357

in the process were lower than those previously reported. A renewable domestic resource such as biomass provides an alternative source of industrially important organic materials. Use of a temperature range between those of liquefaction and biological fermentation ensures product selectivity at reasonable reaction rates. Rice hulls and $AlCl_3$ were heated in an argon-filled reactor from ambient to 175°C. Reaction products collected from 120° to 175° consisted of CO, CO_2, acetone, methylisobutyl ketone, and three unidentified carbohydrates. Intimate contact between the solid $AlCl_3$ and the rice hulls is unnecessary since $AlCl_3$ initiates the thermoconversion process. $AlCl_3$ acts as a reactant rather than as a catalyst. The hemicellulose portion of the rice hulls proved to be the source of these compounds. Lignin and cellulose failed to produce volatile products at 175°C. In addition, $AlCl_3$ was consumed during the hydrolysis procedure.

1358 **Motion of a Sphere in the Presence of a Plane Interface, Part 1: An Approximate Solution by Generalization of the Method of Lorentz;** NSF/RA-790575; California Institute of Technology, Department of Chemical Engineering; Lee SH, Chadwick RS, Leal LG; 1979; NSF Grant No. ENG 7810317

The motion of a sphere in the presence of a fluid-fluid interface is studied. First, a solution is derived for a point force near a plane interface. Then the solution is extended to include the higher-order terms which are required to describe the motion of a solid sphere. Singularities of higher orders at the center of the sphere are obtained by using the method of reflexions. For a fluid-fluid interface with an arbitrary viscosity ratio, the drag force and the hydrodynamic torque are calculated of the special cases of motion of a sphere perpendicular and parallel to the interface. In addition, the rotational motion of a sphere is investigated.

Note: Published in Journal of Fluid Mechanics, Volume 93, Part 4, 1979, pp 705-726.

1359 **Motion of a Sphere in the Presence of a Plane Interface, Part 2: An Exact Solution in Bipolar Co-Ordinates;** NSF/RA-800391; California Institute of Technology, Department of Chemical Engineering; Lee SH, Leal LG; NSF Grant No. ENG 7810317

A general solution for Stokes' equation in bipolar coordinates is derived and then applied to the arbitrary motion of a sphere in the presence of a plane fluid/fluid interface. The drag force and hydrodynamic torque on the sphere are calculated for four specific motions of the sphere--translation perpendicular and parallel to the interface and rotation about an axis which is perpendicular and parallel, respectively, to the interface. The most significant result of this work is the comparison between these numerically exact solutions and approximate solutions from Part 1. In addition to comparisons with the approximate solutions, the predicted changes in the velocity, pressure, and vorticity fields due to the presence of the plane interface are examined. An interesting feature of the solutions is the fact that the direction of rotation of a freely suspended sphere moving parallel to the interface can be the as a sphere rolling along the interphase or opposite, depending upon the location of the sphere center and the ratio of viscosities for the two fluids.

Note: Published in Journal of Fluid Mechanics, Volume 98, Part 1,1980, pp 193-224.

1360 **Pretreatment Methods for the Degradation of Lignin, Final Report;** NSF/RA-800062; Battelle Columbus Laboratories; Allen B R, Cousin, M J, Pierce G E; March 1980; 189 p; NSF Grant No. PFR 7725833; NTIS Order No. PB80-209323/NKS

The goal of this project was to evaluate pretreatment technologies used in processing lignocellulose as a potential new source of lignins. Seven classes of pretreatment processes were identified in the literature review: physical pretreatments (milling and high-energy radiation); thermal pretreatments (controlled heating in air and pyrolytic pretreatment); alkaline pretreatments (sodium hydroxide and ammonia); acidic pretreatments (autohydrolysis, explosive depressurization, dilute acid, concentrated acid, organosolv, and sulfur dioxide); delignification (modified pulping methods); cellulose solvents; and biological pretreatments (biological lignin degradation and enzymatic hydrolysis of hemicellulose). Cost estimates for ten of the processes were obtained. The pretreatments offering the most promise are autohydrolysis, explosive depressurization, dilute sulfuric acid, concentrated hydrochloric acid, organosolv, and cellulose solvents. These pretreatments address the critical problem of separating the major components so that each can be further processed into useful products. They are not too costly to rule out commercial development. Ball milling, electron radiation, and certain modified pulping methods are significantly more expensive.

1361 **Rigorous Cake Filtration Theory;** NSF/RA-800390; University of Akron, Department of Chemical Engineering; Willis MS, Tosun I; 1980; NSF Grant No. ENG 7606224

A filtration theory based on the rigorous, multiphase equations of change contradicts currently accepted concepts of the parabolic filtration correlation. The new theory finds that the least permeable part of the filter cake-septum interface (K_8) controls the filtrate rate, and a decreasing pressure

gradient across this minimum K_8 causes the filtrate rate to decrease; that deviations from parabolic behavior are independent of cake compressibility; that the septum resistance is intrinsically included in K_8 which appears in the slope; that the average porosity is constant and the exit flow rate exceeds the entrance flow rate due to a difference between the surface porosity and the average porosity; that internal variations can be obtained directly from filtration data alone and do not require a compression-permeability simulation; and that the local filtration resistance can exhibit a minimum as a result of using a non-linear transformation from cake length to cake mass.

Note: Published in Chemical Engineering Science, Volume 35, 1980, pp 2427-2438.

1362 **Sedimentation of the Flocculent Suspensions: State-of-the-Art;** NSF/RA-790574; Auburn University, School of Engineering; Fitch B; November 1979; NSF Grant No. ENG 7820965

Three modes or types of sedimentation are recognized in flocculent suspensions: clarification, in which floccules are separated and settle independently; zone settling, in which floccules are incorporated into some solids structure so that all are constrained to subside at more or less the same rate; and compression or compaction, in which the solids structure is strong enough to exhibit a compressive yield value. Current models for sedimentation in the three modes are reviewed, with particular emphasis on their use and reliability (or lack of it) for sedimentation basin design. Most models of thickening presented in the literature derive from a basic partial differential equation for force balance. Models differ in which terms of the equation are disregarded. Several of the theories of compaction are essentially equivalent solutions for the same mode, but with different sets of independent variables.

Note: Published in AIChE Journal, Volume 25, Number 6, November 1979, pp 913-930.

1363 **Surface Combustion of Hydrogen and Other Light Gaseous Fuels in the Presence of an Electrostatic Field and Corona Discharge, Final Report;** NSF/RA-790579; Ohio State University, Engineering Experiment Station; Kulacki FA, Boriah S, Martin SA; December 1979; 150 p; NSF Grant No. ENG 7605032; NTIS Order NO. PB80-228018/NKS

Major achievements of the study are (1) the demonstration that fluid mechanic effects produced by corona discharge in an annular flow reactor can significantly alter mass transfer to a catalytically active outer cylinder; and (2) the measurement of the augmentation of mass transfer coefficients and overall first order rate constants under corona discharge as a function of discharge current, flow rate, and inlet mole fraction of fuel. Experiments were done for hydrogen, ethane, and propane in air at a constant temperature on platinized alumina.

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1364 **Correlations of Seismic Velocity with Depth in Southern California;** NSF/RA-790386; University of California, School of Engineering and Applied Science; Campbell K W, Chieruzzi R, Duke C M; et al; October 1979; 52 p; NSF Grant No. GI 44056; ATA 730323; NTIS Order No. PB80-184080/NKS

This report presents updated correlations relating seismic velocity and Poisson's ratio with depth and various geotechnical parameters for different soil and rock classifications found in Southern California. Such correlations are very useful in earthquake engineering applications. The current study updates previous work by incorporating prior data with 48 new velocity measurements. Data were obtained from borings drilled as a part of geotechnical investigations. In addition to establishing updated velocity correlations, these new data improved and extended a previously developed geotechnical classification system. The report presents new shear-wave and compressed wave velocity together with supporting geotechnical data. Statistics are compared for each classification for surface and near-surface velocities of both shea and compressional waves and for Poisson's ratios. Correlations to depth are presented for a few of the classifications for which sufficient data are available. The geotechnical parameters significant to seismic velocity and Poisson's ratio include geologic age, gravel content, water table depth, dry density, and depth of overburden.

1365 **Direct Simple Shear Behavior of Fine Grained Soils Subjected to Repeated Loads, Interim Report;** NSF/RA-790487; Rensselaer Polytechnic Institute, Department of Civil Engineering; Floess CHL, Zimmie TF; December 1979; 199 p; NSF Grant No. PFR 7818743; NTIS Order No. PB80-212525/NKS

Consolidated constant volume static and cyclic loading tests were performed using the Norwegian Geotechnical Institute's direct simple shear device. Emphasis was placed on high level repetitive loading, such as that caused by earthquakes and storm waves. Tests were performed using a square wave pulse shape with complete stress reversal on Gulf of Alaska and Blue Concord clays. Lateral stresses acting on soil samples were measured by means of calibrated, wire-reinforced rubber membranes. The membranes provided a convenient method of experimentally determining the coefficient of lateral stress at rest, K_o. The measured value of K_o for Gulf of Alaska clay was 0.54. Lateral stress measurements also provided sufficient information to determine Mohr's circle of stress for an infinitesimal element of soil at the center of the sample. It was determined that the coefficient of lateral stress increases with greater shear strain, and that the horizontal plane of the sample is approximately the plane of maximum shear stress, not the plane of maximum obliquity. Cyclic loading failure does not occur if the cyclic shear stress is small. For both clays, the critical level of repeated loading is approximately 25 percent of the peak static undrained shear strength. For lightly overconsolidated Concord Blue clay, the critical level of repeated loading is about 15 percent.

1366 **Dynamic Response of a Buried Pipe in a Seismic Environment;** NSF/RA-800214; University of Colorado, Department of Mechanical Engineering; Datta SK, Shah AH, El-Akily N; August 1980; 36 p; NSF Grant No. PFR 7822848; NTIS Order No. PB81-119513/NKS

Axisymmetric dynamic response of a buried pipe due to an incident compressional wave is reported. The pipe was modelled as a thin cylindrical shell of linear homogeneous isotropic elastic material embedded in a linear isotropic homogeneous elastic medium of infinite extent. The response characteristics of the pipe due to changes in the material properties of the surrounding medium were analyzed. It was found that even at long wavelengths and low frequencies the dynamic response was significantly altered by the changes in the Poisson's ratio and the rigidity modulus of the surrounding medium. In addition, it was found that there were real resonant frequencies of the pipe which proved significantly dependent on these quantitites as well as on the wavelength.

1367 **Dynamic Stiffness and Seismic Response of Sleeved Piles;** NSF/RA-800089; Massachusetts Institute of Technology, Department of Civil Engineering; Kaynia AM, Kausel E; May 1980; 62 p; NSF Grant No. PFR 7902989; NTIS Order No. PB80-216633/NKS

An axisymmetric finite element formulation with a consistent transmitting boundary is used to obtain dynamic stiffnesses and seismic response of sleeved piles in linear viscoelastic soil media. A sleeved pile consists of a column within a sleeve of substantially larger diameter which is filled with concrete to some depth below grade level. Recent research on the behavior of pile-foundations under dynamic loads has been stimulated by dynamic behavior studies which have disclosed that the effects of soil structure interaction can be significant. Two approaches were used in the study: a finite element formulation with a consistent transmitting boundary to stimulate the soil medium encircling the pile and an approximate analytical method based on the concept of a generalized Winkler medium. From the approximate analytical method, closed-form expressions were derived for the dynamic stiffness of the piles. Comparison of the results of the analytical and the finite element formulation methods showed that the analytical method, together with the appropriate subgrade moduli also obtained in this study, provide fairly accurate results for dynamic stiffnesses at low as well as at high frequencies.

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1368 **Earthquake Risk and Damage Functions: An Integrated Preparedness and Planning Model Applied to New Madrid, Final Report;** NSF/RA-790428; Midwest Research Institute; Liu BC, Hsieh CT, Gustafson R, et al; December 1979; 335 p; NSF Grant No. ENV 7715669; NTIS Order No. PB80-170368/NKS

This study attempts to provide, in an integrated analytical framework, the methodology and the data needed to guide public and private planning and future decision-making for earthquake hazard preparedness and risk mitigation. Focus is on the New Madrid Fault region, especially the effect on the St. Louis and Memphis Standard Metropolitan Statistical Areas. An interdependent planning simulation model was developed to tie together statistically the seismic risk or physical damage functions to economic damage functions for potential earthquake risk assessment and impact evaluation for the next 50 years. Several topics are covered: (1) Various seismological risks in the New Madrid region are described and predicted; (2) The surficial materials are documented and ground susceptibility for the region is classified; (3) Populations subject to earthquake risk and the projected populations, 1980 through 2030, are discussed; (4) The development of the physical and economic damage functions and their applications to damage estimation and impact assessment under the "status quo" scenario are presented; and (5) The institutional aspects and policy issues concerning earthquake risk deduction and preparedness are shown.

1369 **Earthquake Threat, The Human Response in Southern California;** NSF/RA-790075; University of California, Institute for Social Science Research; Turner R H, Nigg J M, Paz D H, et al; 1979; 159 p; NSF Grant No. ENV 7624154; PFR 7823887; NTIS Order No. PB80-164734/NKS

The community's ability to deal constructively with the prospect of a severe earthquake is discussed. Described is the public's state of mind one year after announcement of the Southern California Uplift. Using information from a 1977 survey of 1450 adult residents of Los Angeles County, the sample was designed to be representative of the entire country. The extent to which people are aware of the Uplift and of the various predictions, forecasts, and cautions concerning possible earthquakes in the near future is addressed. Public expectations are examined and an attempt is made to see whether they are related to events of the preceding year. Questions concerning preoccupation with, and concern and fear of, earthquakes are explored. Topics covered are: (1) whether people wish to be informed or sheltered from anxiety-provoking communications; (2) whether and how action should be taken; (3) response to earthquake hazard, including attempts to seek earthquake threat information; (4) degree of confidence placed in scientific earthquake prediction; and (5) general attitudes toward science.

1370 **Effect of Local Inhomogeneity on the Dynamic Response of Pipelines, Grant Report No. 14;** NSF/RA-790528; Weidlinger Associates, Consulting Engineers; Nelson I, Weidlinger P; October 1979; 106 p; NSF Grant No. PFR 7815049; NTIS Order No. PB81-122533/NKS

The dynamic axial response of long segmented pipelines induced by incoherent seismic ground motion in inhomogeneous soil conditions is reported. Seismic response of pipeline "lifelines" is important because of the potential grave consequences of an earthquake disruption of vital services. Results indicate that, in general, a local inhomogeneity may contribute to a change in pipe response in three different ways: (1) a local variation in delay time in the case of wave propagation; (2) a variation in the free field waveform adjacent segments caused by inhomogeneity; and (3) a variation in soil stiffness from soft to firm material. All three effects generally occur simultaneously. Changes in the phase delay are not significant. Large amplifications in pipe response, relative to the homogeneous case, can occur when the incoherent component of the input ground motion is large. For a two-degree-of-freedom system, a local change in soil stiffness can cause a large increase in pipe response, even for a coherent ground input. A two-degree-of-freedom system appears to be a reasonable model for the behavior of a multisegment system.

1371 **Foundation Theories of Solute Transport in Porous Media: A Critical Review;** NSF/RA-790545; University of California, Department of Soil and Environmental Sciences; Sposito G, Gupta VK, Bhattacharya RN; 1979; 10 p; NSF Grant No. ENG 7609210; ENG 7609081

Theories used to derive macroscopic differential equations that describe solute transport through porous media are reviewed critically. They are grouped into three classes based on: (1) fluid mechanics; (2) kinematic approaches employing the mathematics of the theory of Markov processes; and (3) a formal analogy between statistical thermodynamics and hydrodynamic dispersion. The theories of Class 1 employ highly artificial models of a porous medium to produce a well-defined velocity field in the pore space that can be analyzed rigorously. Or they assume that well-defined solutions of fluid mechanics equations exist in the pore space of a natural porous medium, adopting an ad hoc definition of the solute diffusivity tensor. The theories of Class 2 do not require the validity of fluid mechanics but suffer from the absence of a firm dynamic basis at the molecular level for the stochastic properties they attribute to the velocity of a solute molecule. Or they ignore dynamics altogether and make kinematic assumptions directly on the position process of a solute molecule. The theories of Class 3 have been purely formal in nature with an unclear physical content. None of these theories has achieved the objectives of deriving the

macroscopic differential equations of solute transport theory and of elucidating the structure of the empirical coefficients appearing in these equations.

Note: Published in Advances in Water Resources, Volume 2, June 1979, pp. 59-68.

1372 **Frequency Domain Identification of Structural Models from Earthquake Records;** NSF/RA-790437; California Institute of Technology, Earthquake Engineering Research Laboratory; McVerry GH; October 1979; 224 p; NSF Grant No. PFR 7723687; NTIS Order No. PB80-194301/NKS

The usefulness of simple linear mathematical models for representing the behavior of tall buildings during earthquake response is investigated for a variety of structures over a range of motions including the onset of structural damage. The linear models which best reproduce the measured response of the structures are determined from the recorded earthquake motions. A systematic frequency domain identification technique is developed to determine the optimal models. The periods, dampings, and participation factors are estimated for dominant structural modes in the measured response. A method is developed to identify a single linear model appropriate for the entire response, or to approximate the nonlinear behavior exhibited by structures with a series of models optimal for different segments of the response. The study investigated earthquake records obtained from 10 structures ranging in height from 7 to 42 stories. The maximum response amplitudes ranged from approximately 0.25g to 0.40g. Very small amplitude responses were produced well by linear models with fundamental periods similar to those measured in vibration tests. The close reproductions of measured motions confirm the accuracy of linear models with only a few modes for representing behavior during earthquake response of tall buildings in which no structural damage occurs.

1373 **High-Strength Concrete: An Annotated Bibliography 1930-1979;** NSF/RA-800372; Cornell University; Carrasquillo RL; Nilson AH; Slate FO; 1980; NSF Grant No. ENG 7608752

Presented is a guide to the existing literature on high-strength concrete, including most of the relevant writings in the English language as well as some writings in other languages. High-strength concretes are here defined as concretes with strengths considerably higher than usually obtained by a given production process. There is general agreement on the need for a unified effort for the development of knowledge of this new material so that it may be used with confidence in design and construction. The articles referenced describe properties, methods of production, laboratory tests, and applications. Coverage is to April 1979. Entries are organized alphabetically by author. Complete author and subject indexes are provided.

Note: Published in Cement, Concrete and Aggregates, Volume 2, Number 1, 1980, pp 3-19.

1374 **Inelastic Seismic Response of a Torsionally Unbalanced Single-Story Building Model (Seismic Behavior and Design of Buildings, Report No. 2);** NSF/RA-790389; Massachusetts Institute of Technology, School of Engineering; Irvine HM, Kountouris GE; July 1979; 172 p; NSF Grant No. ENV 7714174; NTIS Order No. PB80-164197/NKS

The dynamic effects of coupling between torsion and translocation using a simple torsionally unbalanced single-story building model are described. The investigation deals with a two-degree-of-freedom model in which two frames support a diaphragm in which the center of mass may be offset from the center of stiffness. Frames are assumed to behave as simple elastic-plastic springs and to have the same stiffness and strength levels. A comprehensive parameter study was undertaken to identify trends in the peak ductility demands of the worst situated frame. Results are plotted and interpreted. A simple frequency domain analysis outlines why the peak ductility demands occur in the frame farthest from the center of mass. The study indicates that the most important parameter is one involving the product of diaphragm mass and spectral acceleration normalized by a yield level in the frame. For wide ranges of other parameters, the peak ductility demand is roughly linear in this parameter, a characteristic of symmetric structures. Eccentricity does not appear to be a significant parameter. A regression analysis of the data yielded simple confidence levels for peak ductility demands.

1375 **INRESB-3D—A Computer Program for Inelastic Analysis of Reinforced Concrete Steel Buildings Subjected to 3-Dimensional Ground Motions, Report No. 2;** NSF/RA-790400; University of Missouri-Rolla, Civil Engineering Department; Cheng FY, Kitipitayangkul P; August 1979; 104 p; NSF Grant No. ENV 7518372; NTIS Order No. PB80-176944/NKS

This user's guide for the computer program INRESB-3D analyzes elastic and inelastic building systems subjected to the simultaneous input of static loads and multicomponent earthquake motions, which can be applied in any direction of the structural plane. The building systems may have elevator cores, floor diaphragms, and shear walls of reinforced concrete, as well as beams, columns, and bracing. The computer program has been developed to achieve efficiency in both computation and data preparation. The output solutions include the static results of member forces and nodal displacements, as well as the dynamic results of member forces, nodal

displacements, ductility factors, excursion ratios, seismic input energies, dissipated energies, and the options of plotting some of the dynamic results. Included are a program list, a description of program, instructions for data preparation, and a guide to modify the program's capacity.

1376 **Investigation of the Effect of 3-D Parametric Earthquake Motions on Stability of Elastic and Inelastic Building Systems, Report No. 1;** NSF/RA-790309; University of Missouri at Rolla, Civil Engineering Department; Cheng FY, Kitipitayangkul P; August 1979; 396 p; NSF Grant No. ENV 7518372; NTIS Order No. PB80-176936/NKS

The effect of interacting, three-dimensional ground motions on the response behavior of elastic and inelastic building systems is investigated. The building systems may have elevator cores, floor diaphragms, and shear walls of reinforced concrete as well as steel beams, columns, and bracings. The stiffness matrices are derived from the Ramberg-Osgood hysteresis model for steel and Takeda's model for concrete. The geometric matrix is formulated for the second-order effect on large deflections. The interacting forces on the yielding surfaces of the members are included. A computer program, INRESB-3D, has been comprehensively developed for achieving efficiency in both computation and data preparation. A total of 26 numerical examples have been studied for various low-rise and high-rise building systems, which show that an interacting ground motion can significantly increase internal forces, nodal displacements, ductilities, and seismic input and dissipated energy. The large ductilities and the excessive permanent deformations induced by a coupling motion exhibit severe local damage and thus diminish the serviceability of a structure.

1377 **Managing Flood Hazard Areas: A Conceptual Framework for Evaluating Program Effectiveness;** NSF/RA-800115; University of North Carolina, Center for Urban and Regional Studies; Burby RJ, French SP, Kaiser EJ; April 1980; 220 p; NSF Grant No. DAR 7807603; NTIS Order No. PB80-223795/NKS

A formulation and conceptual framework for evaluating flood plain land use management is described. Questions about the effectiveness of land use management as it relates to the nation's current approach to flood problems are addressed. The conceptual framework considers the context, role, objectives, components, and impacts of flood plain land use management programs. Issues involved in measuring program effectiveness are discussed, and an approach is developed to explain why the impacts and effectiveness of land use management programs vary from one community to another. Other issues examined are: (1) determination of the state of the art of flood plain land use management in the U.S.; (2) development of operational measures of effectiveness and a methodology for using them in monitoring and evaluating community flood plain land use management programs; and (3) an assessment of proposed measures and methods based on field-level trial applications in three communities. The report concludes with a brief explanation of possible uses of the conceptual framework, including providing guidance in constructing an operational methodology for evaluating the effectiveness of flood plain management.

1378 **Managing Flood Hazard Areas: The State of Practice;** NSF/RA-800113; University of North Carolina at Chapel Hill, Center for Urban and Regional Studies; French SP, Burby RJ; January 1980; 50 p; NSF Grant No. DAR 7807603; NTIS Order No. PB80-221823/NKS

Many communities and regional agencies have become involved in flood plain land use management as a result of the National Flood Insurance Program, the Coastal Zone Management Program, numerous state programs, and the initiative of local citizens. This report describes current practices in flood plain land use management existing in these agencies. The data presented were derived mainly from two mail surveys conducted in the spring of 1979. The first survey was directed to a sample of local agencies involved in the National Flood Insurance Program. Members of the National Association of Regional Councils received the second survey. Information on the goals, methods, and implementation of flood plain land use management was gathered. Local and regional perceptions of the relative effectiveness of various methods, the overall effectiveness of agency efforts, and the major obstacles to better flood plain land use management were also obtained. The major findings are summarized.

1379 **Nonlinear Dynamic Stiffness of Piles;** NSF/RA-800088; Massachusetts Institute of Technology, Department of Civil Engineering; Angelides DC, Roesset JM; April 1980; NSF Grant No. ENV 7718339; 40 p; NTIS Order No. PB80-221898/NKS

The effect of nonlinear soil behavior, without slippage or gapping, on the dynamic response of piles is explored. This research uses a finite element model for the soil region adjoining the pile, a consistent boundary matrix at some distance to reproduce radiation effects, and an iterative, equivalent linearization technique to estimate the variation of soil properties with level of strain. A cylindrical region of soil surrounding the pile is discretized using toroidal finite elements. The pile is modeled as a series of beam segments attached through rigid links to the finite element nodes. The results consider hollow, floating piles with aspect ratio (length over diameter) equal to 45. The top of the pile is assumed to be free. Comparing the results of this analysis with those obtained using the p-y curves, it seems that the main difference is due to the lack of tension capacity in the soil and the appearance of

gaps for larger forces. The results for the horizontal case indicate that as the level of force increases, there is an increase in internal soil damping, but a decrease in radiation. When both effects are combined, the effective damping ratio tends to increase.

1380 **Performance of Low Rise Buildings—Existing and New;** NSF/RA-800221; Purdue University, School of Civil Engineering; Yao JTP; July 1980; 17 p; NSF Grant No. PFR 7906296; NTIS Order No. PB81-119539/NKS

An evaluation of the safety-related seismic performance of existing low-rise building structures is described. The theory of structure reliability is reviewed and error and defect related failures for new constructions are assessed. Failures related to wearout and deterioration also are discussed. Estimation of structural reliability requires determination of the configuration, material, and type of construction. The behavior of an existing completed structure may not correspond to the mathematical model used prior to construction. For certain important structures, nondestructive tests are performed to collect selected load and response data. Techniques of system identification then are applied to obtain a more selective mathematical model for further analysis. An existing structure can be tested either periodically or immediately following an extreme event. Literature relating to new construction failure is reviewed. The need for a set of standard nondestructive testing and inspection techniques is discussed.

1381 **Rule-Inference Method of Damage Assessment of Existing Structures;** NSF/RA-800220; Purdue University, School of Civil Engineering and School of Electrical Engineering; Ishizuka M, Fu KS, Yao JTP; July 1980; 13 p; NSF Grant No. PFR 7906296; NTIS Order No. PB81-119521/NKS

A damage assessment methodology to determine the damage states of existing structures after an earthquake is described. A definitive and rational methodology can contribute to correct decisions in repairing structures, predicting future damage, and improving technologies for aseismic structures. The proposed approach implements an inference or reasoning procedure similar to that used by experts in computer programming. It consists of a question-and-answer subsystem which facilitates an efficient interactive man-machine interface and responds upon request of the user and controller to collect necessary data for assessment. Data include field observations and as much structural information as possible with respect to the building being assessed. Time-records of the accelerometers located in various stories are analyzed in the pattern recognition system. A block of control, inference, and classification sends requests to the connected blocks to accept necessary information. The inference is performed consulting a knowledge base, and the result is classified into one of the damage state categories and reported through output processing. Recent full-scale dynamic tests will be useful in developing a new methodology for damage assessment of existing structures.

1382 **Sample Size Effects Using the NGI Direct Simple Shear Apparatus, Interim Report;** NSF/RA-790485; Rensselaer Polytechnic Institute, Department of Civil Engineering; Carroll MD, Zimmie TF; 1979; 144 p; NSF Grant No. PFR 7818743; NTIS Order No. PB80-216609/NKS

Tests were conducted using undisturbed soil samples of Gulf of Alaska and Gulf of Mexico clays in order to improve the use of the interpretation of results of the Norwegian Geotechnical Institute's direct simple shear device modified for cyclic loading. The effects of variations in sample size are quantified. The parameters which varied were sample cross section and sample height. Two cross-sectional sizes and three heights were compared. Equipment used in the investigation, testing procedures, and soil characteristics are discussed. Test data reported include lateral strain measurements from which horizontal normal stresses, and subsequently the initial lateral stress ratio values, were calculated. These calculations and results are discussed as affected by sample size, with special attention to the initial lateral stress ratio. Step-by-step instructions on the use of this direct simple shear device in both static and cyclic functions are explained. The use of the sample trimming apparatus and methods for calibrating the reinforced membranes using calibration cyclinders are detailed.

1383 **Simulation of Strong Earthquake Motion with Contained-Explosion Line Source Arrays, Single-Source and Array Tests at Camp Parks, Final Report;** NSF/RA-790207; SRI International; Bruce J R, Lindberg H E, Abrahamson G R; December 1979; 155 p; NSF Grant No. PFR 7800993; NTIS Order No. PB80-201445/NKS

The development of a technique using explosives to simulate strong level, earthquake-like ground motion is described. The long-range objective is in situ testing of soil structure interaction and of structures with complex internal equipment systems. The technique can be applied to buildings, nuclear reactors, pipelines, power lines, dams, bridges, and tunnels. It produces ground motion by simultaneous firing of a planar array of vertical line sources. The controlled release of high-pressure explosion products within each source allows controlled pressurization of the surrounding soil. Tests were performed with an array of ten 1/3-scale sources. Tests were also performed with single sources, both in 1/3-scale and full-scale. A quasistatic theory was developed to predict both single-source and array response. The 1/3-scale array test results, when compared to 1/3-scale single-source test results, showed a more than order

magnitude increase in ground motion. The quasistatic theory predicted this result and compared favorably with both the single-source and array tests. Extrapolation of these results to full-scale showed that an 80 x 40-ft. array can produce accelerations of 0.6 g, velocities of 1 ft./s, and displacements of about one inch at frequencies of 3-5 hz, a useful level of ground motion for structural testing.

1384 **Site Characterization and Exploration, Proceedings of a Specialty Workshop (Northwestern University, June 12-14, 1978)**; NSF/RA-790198; Northwestern University; American Society of Civil Engineers; Dowding C H, Editor; June 1978; 396 p; NSF Grant No. ENG 7712239; NTIS Order No. PB80-197825/NKS

The process of exploring to characterize or define small scale properties of substrata at construction sites provided the focus of this workshop. This volume contains the focal challenge paper, 16 position papers responding to the challenge, discussion following the position papers, and a ranked summary of research needs in site characterization. Topics including exploration contracts, use of probability and reliability, development of appropriate geophysical devices, need for standard test sites, use of decision analysis, and three-dimensional display drew considerable attention. Discussions and position papers were grouped in the following sessions: (1) Design and Analytical Needs for Site Characterization; (2) In Situ Contact Sensing and Laboratory Testing; (3) Site Representation and Exploration Decisions; and (4) Remote In Situ Sensing.

1385 **Static and Quasi-static Seismic Analysis of Buried Pipelines (Seismic Vulnerability, Behavior and Design of Underground Piping Systems) Technical Report No. 11**; NSF/RA-800157; Rensselaer Polytechnic Institute, Department of Civil Engineering; Wang LRL; June 1980; 116 p; NSF Grant No. PFR 7815856; NTIS Order No., PB81-103202/NKS

Currently available static and quasi-static analyses for the seismic response behavior of buried pipelines are summarized to evaluate the adequacy of existing pipelines and to aid in the design of future systems. The analyses employed include the upper bound--both simplified and quasi-static approaches; static-beam on elastic and elastic-plastic foundation models; and quasi-static elastic and elasto-plastic analyses. Upper bound analyses are simple but conservative, and the bounds are used as a basis of normalization of results. Static analyses are a higher level of analysis, while quasi-static analyses constitute the highest level examined. Results indicate that: (1) the seismic response behavior of buried pipelines is controlled by ground displacement characteristics, not by ground accelerations; (2) pipe strain and relative joint displacements are jointly taken up by the imposed earthquake bound displacement; (3) responses are larger under softer soil conditions; (4) responses are higher when there is no slippage between soil and pipe; and (5) a longer pipe segment produces high pipe strain and larger relative joint displacement for segmented pipelines.

1386 **Tsunamis (Proceedings of the National Science Foundation Workshop, May 1979)**; NSF/RA-790530; Tetra Tech, Inc.; Hwang LS, Lee YK, Editors; May 1979; 317 p; NSF Grant No. PFR 7805646; NTIS Order No. PB81-116436/NKS

The purpose of this workshop was to provide a forum for a critical review of the status of tsunami research. The program sessions offered presentations to analyze six main topics: tsunamigenic earthquakes; tsunami generation; tsunami propagation; coastal transformations and terminal effects; numerical aspects of tsunami modeling; and coastal protection. Each review served as a focus and guide for further discussions by workshop participants. Following the proceedings of the workshop, a report by the Tsunami Research Advisory Committee is presented. A subject outline, a summary of pertinent discussion and recommendations, and suggestions for future action are included.

1387 **Water Quality Modelling of Mine Acid Drainage, Water Resources and Environmental Engineering Research Report, Interim Report**; NSF/RA-790578; State University of New York at Buffalo, Department of Civil Engineering; Uchida A; August 1979; 228 p; NSF Grant No. ENG 7715365; NTIS Order NO. PB81-105827/NKS

Two steady-state, one-dimensional water quality models applicable to the streams receiving mine drainages are presented. The first model assumes chemical characteristics of the stream waters to be represented by the system of aqueous carbonate-sulfate equilibria. The exchange of carbon dioxide across the air-water interface was assumed to be the only significant sink-source of inorganic carbon. Essential aspects of the model were tested in a bench-scale laboratory experiment. A comprehensive model is then presented which takes into consideration kinetics of ferrous iron oxidation, growth and decay of iron-oxidizing bacteria, and interfacial exchanges of oxygen and carbon dioxide, as well as chemical precipitation-dissolution reactions. The aqueous chemical system is modelled for 42 species that are commonly present in mine drainage waters.

1388 **Wind Climate, Proceedings of the Workshop (Asheville, North Caroline, November 12-13, 1979)**; NSF/RA-790495; Texas Tech University, Institute for Disaster Research; Mehta KC, Editor; 249 p; NSF Grant No. PFR 7906294; NTIS Order No. PB80-218290/NKS

All aspects of wind data systems were presented in papers by 24 meteorological and engineering professionals. The workshop had several objectives: (1) to illustrate application of wind data; (2) to review available wind data, its quality and limita-

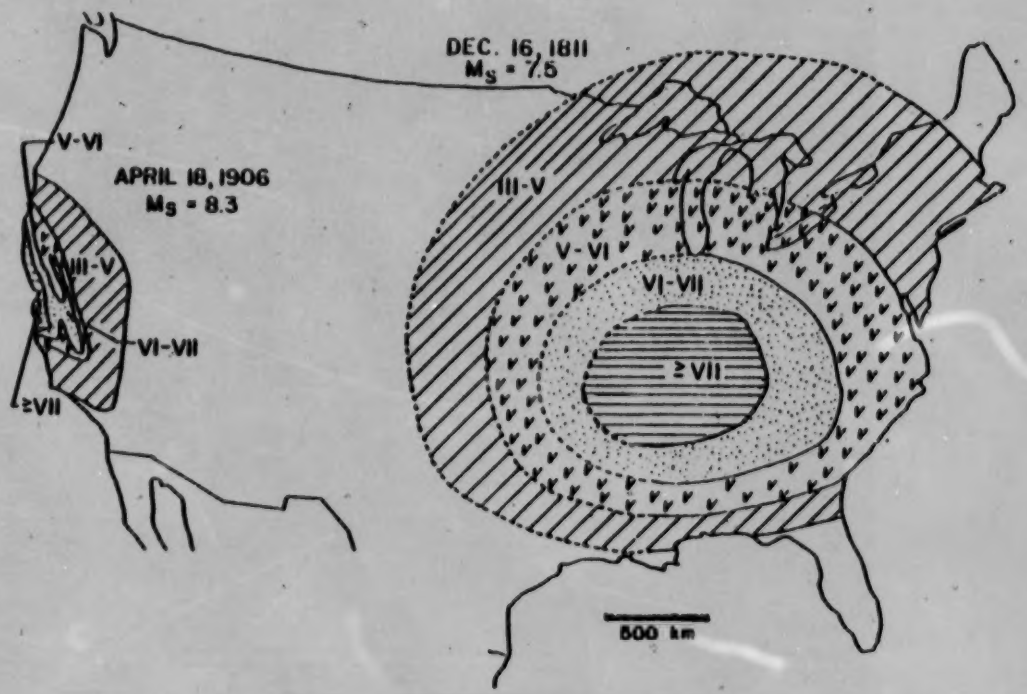

Figure I-4 - Intensity maps for the San Francisco earthquake of April 18, 1906, and the Mississippi Valley earthquake of December 16, 1811. (The damage areas would correspond to those of M.M. intensity VII and greater).

See Entry 1384

tions; (3) to discuss ways of modeling and characterizing the wind climate from meteorological data; and (4) to deliberate needs and areas of improvement in acquiring meteorological data for climate description. Specific papers concerned applications of wind data and the definition of needs, wind collection and storage of meteorological data by the Forest Service, data collection and storage by the National Climatic Center, wind data from conventional measurement systems, and adjustment and analysis of data for regional wind energy assessments. Also discussed were climatic modeling and wind data analysis with respect to modeling and wind climate, estimation of extreme speeds in mixed wind climates, meteorological tower data archiving at the Boulder Atmospheric Observatory, and climatology of tornado parameters.

DIRECTORATE FOR ENGINEERING

Division of Civil and Environmental Engineering: Computer Programs†

*1389 **ACE—Analysis of Critical Elements for the Seismic Evaluation of Existing Multistory Residential Buildings;** Program Number: 46-1178; NSF/RA-771084; S.B. Barnes & Associates; J.H. Wiggins Company; Pinkham CW, Hart GC; NSF Grant No. PFR 7720667

A methodology is presented for evaluating the need to upgrade existing buildings by identifying items requiring strengthening or repair, and then by verifying the adequacy of rehabilitation. This evaluation is given in terms of the behavior of the critical structural elements in a building. The determination of this behavior requires an analysis of the structural response of the building to prescribed forces. An analytical model of the building is defined with data collected from a field inspection of the building, original structural calculations and drawings, text records, and tests of the existing building materials. The Uniform Building Code (UBC73) serves as the basis for calculations made with the analytical model.

*1390 **ADAP—Static and Dynamic Analysis of Arch Dams;** Program Number: 16-1273; NSF/RA-K-73-169; University of California, Department of Civil Engineering; Clough, RW, Raphael JM, Mojtahedi S; June 1973; NSF Grant No. PFR 7720667

ADAP is a finite element program capable of performing linear static and dynamic analysis of arbitrary arch dam-foundation systems. Most of the logical features and many of the sub-routines of the computer program "SAP" are utilized. Special features associated with preparation of input data are incorporated to make it more suitable for arch dam analysis. Three different element types included in the program are considered to be the most suitable in this application. The program is organized in such a way that new elements can be included in it easily. A finite element mesh is automatically generated from a minimum amount of input informaton. In each problem any one of the following types of analysis can be requested: (1) static analysis; (2) evaluation of natural frequencies and mode shapes; (3) response history analysis; and (4) response spectrum analysis. The program has been coded in FORTRAN IV and can be used on the CDC 6400, 6600, and 7600 computers.

*1391 **ANSR-1—General Purpose Program for Analysis of Non-Linear Structural Response;** Program Number: 32-976; NSF/RA-K-75-203; University of California, Department of Civil Engineering; Mondkar DP, Powell GH; December 1979; NSF Grant No. PFR 7720667

ANSR is a general purpose computer program for static and dynamic analysis of nonlinear structures incorporating discrete finite elements. Each node may possess up to six degrees of freedom. Static loads are applied in a series of load increments, each specified as a linear combination of static force patterns. This feature permits application of non-proportional loads. Dynamic loading may consist of earthquake ground accelerations, time-dependent nodal loads, or prescribed initial values of nodal velocities and accelerations. The finite elements available are a three dimensional truss element, which may yield in tension or buckle elastically in compression; and a two dimensional 4-to-8 node finite element for plane stress, plane strain, and axisymmetric analysis. Large displacements may be included. The material may be specified to be isotropic linearly elastic, orthotropic linearly elastic, or isotropic elastic-perfectly plastic with the von Mises yield function. Nonlinearities are introduced at the element level only, and may be due to large displacements, large strains and/or nonlinear materials. The program is written in FORTRAN IV for the CDC 6400/6600/7600.

*1392 **ANSR-1: INEL2 and INEL3—Three Dimensional Inelastic Frame Elements;** Program Number: 53-1179; NSF/RA-780895; University of California, Department of Civil Engineering; Riahi A, Row DG, Powell GH; August 1978; NSF Grant No. PFR 7720667

This program combines ANSR, a general computer program for static and dynamic analysis of nonlinear structures, with two elements: (1) INEL2--a beam-column having two dimensional stiffness and yield characteristics intended primarily for modelling beams; and (2) INEL3--a beam-column which has three-dimensional stiffness and yield characteristics. It can be used for modelling columns in which biaxial bending effects may be important and also for structures such as elevator shafts. Both elements assume that inelastic behavior is concentrated in plastic hinges at the element ends. For INEL2, the plastic hinges are affected by moment in the principal bending plane only, or by this moment interacting with axial force. For INEL3, the plastic hinges are affected by bending moments about both axes, axial force, and torsional moment. Allowance has been made for rigid floor diaphragms by means of a "slaving" feature incorporated into both elements at the element level, because ANSR-1 cannot account for slaving at the nodal level. Both elements also allow for rigid end zones and for initial element actions.

*1393 **APOLLO . . . Analysis of Potential Liquefaction of Soil Layers for One Dimensional Seepage;** Program Number: 50-0779; NSF/RA-780896; University of California, Department of Civil Engineering; Martin PP, Seed HB; October 1978; NSF Grant No. PFR 7720667

APOLLO incorporates a simplified procedure for one dimensional analysis of generation and dissipation of pore water pressures in a sand deposit due to seismic excitation. The method of liquefaction analysis is outlined by determining (1) dynamic response of the soil deposit under investigation; (2) equivalent uniform cyclic stress, equivalent number of uniform stress

*For ordering information, see Appendix B.

†See also entry 1375.

cycles, and effective period of each cycle representing the induced history for each depth in the soil profile; (3) relationships between applied cyclic sheer stresses and number of stress cycles required to produce a condition of initial liquefaction under undrained conditions from cyclic load tests; (4) number of stress cycles required to cause initial liquefaction; (5) rate of pore pressure build up for each elemental layer of the deposit; (6) corresponding values of the coefficient of consolidation for the different layers from a knowledge of the coefficients of permeability and compressibility of the soil layers; (7) the governing differential equation for the known values of soil characteristics, pore pressure generation expressions and boundary conditions. The program is used to solve this equation by an implicit finite difference method.

*1394 **ASHSD2 . . . Dynamic Stress Analysis of Axisymmetric Structures under Arbitrary Loading;** Program Number: 25-975; NSF/RA-K-69-003; University of California, Department of Civil Engineering; Ghosh S, Wilson EL; September 1969; Revised October 1974; NSF Grant No. PFR 7720667

This program evaluates the time dependent displacements and stresses of complex axisymmetric structures subjected to any arbitrary static or dynamic loading or base acceleration. The three dimensional axisymmetric continuum is represented as an axisymmetric thin shell or a solid of revolution or a combination of both. The axisymmetric shell is discretized as a series of frustrums of cones and the solid of revolution as triangular or quadrilateral toroids connected at their nodal point circles. The program can solve five cases of loading: dead load; arbitrary static load; arbitrary dynamic load; and horizontal and vertical component of earthquake acceleration record applied at the base of the finite element model. Arbitrary loading is first approximated by a Fourier series with a finite number of terms. After solving for the response of all the Fourier terms, their contributions are summed up to obtain the total response. Written in FORTRAN IV for CDC 6000 series computers, ASHSD2 uses dynamic storage allocation. A separate version of the program for static analysis only (ASHSAB) contains in-core as well as out-of-core equation solvers.

*1395 **CAL . . . Computer Analysis Language for the Static and Dynamic Analysis of Structural Systems;** Program Number: 37-1178; NSF/RA-771085; University of California, Department of Civil Engineering; Wilson EL; January 1977, revised November 1978; NSF Grant No. PFR 7720667

CAL is a matric interpretive language and a small capacity structural analysis program. It can be considered as a replacement for the program SMIS. The present version has three different elements - 3D truss, 3D beam, and 3 to 8 node plane stress isoparametric element. Dynamic analysis can be performed by either the step-by-step or mode super-position method. The program is written in FORTRAN IV, has run on the CDC 6400 and is designed to run on minicomputers with a minimum of modifications. It contains over 40 subroutines which can be used within CAL in the development of other programs. Some of these are printing, plotting, addition, subtraction, multiplication, inversion, solution of equations, submatrix manipulation, eigenvalues and vectors, step-by-step solution of the dynamic equilibrium equations and generation of element stiffness and mass matrices.

*For ordering information, see Appendix B.

*1396 **CHARSOIL . . . Characteristics Method Applied to Soils;** Program Number: 19-674; NSF/RA-K-74-188; University of Michigan; Streeter VL, Wylie EB, Richart FE Jr; March 1974; NSF Grant No. PFR 7720667

CHARSOIL is an application of a method for calculating one-dimensional dynamic behavior of soils. A constant thickness zoned soil may consist of layers each having specific properties--shear modulus, density, maximum shearing strength, and visco-elastic coefficient. Underlying the soil is a rock base which may be horizontal or inclined. Dynamic excitation of the soil is introduced at the rock-soil interface by shearing stresses produced by rock motions. At the upper surface of the soil a slab may be included to simulate the dynamic influence of the weight of a building. Response of the soil can be evaluated on the basis of elastic, viscoelastic, or nonlinear soil behavior and plastic slip can be included.

*1397 **CUMLIQ . . . Evaluation of Potential for Liquefaction of a Soil Deposit Using Random Vibration Procedures;** Program Number: 20-674; NSF/RA-K-74-189; Dames & Moore; Donovan NC; June 1974; NSF Grant No. PFR 7720667

This program consists of a main program (MAIN) and two subroutines (STODAM and PLOTP). Originally developed for use in seismic design work for the Trans-Alaska Pipeline, its purpose is to estimate the potential for seismic liquefaction using known field and laboratory data of soils in combination with general statistical parameters of earthquakes. It is designed to perform the operation according to the mathematic procedure described in the Proceedings of the First International Conference of Applications of Statistics and Probability to Soil and Structural Engineering, Hong Kong, 1971, pp. 514-535. The sequence of operations is provided.

*1398 **DAEM . . . Detailed Analytical Evaluation Method for Natural Hazards Evaluation of Existing Buildings;** Program Number: 31-976; NSF/RA-K-75-204; National Bureau of Standards, Center for Building Technology; J.H. Wiggins Company; S.B. Barnes and Associates; Culver CG, Lew HS, Hart GC, et al; January 1975; NSF Grant No. PFR 7720667

DAEM provides the basic tools for evaluation of potential damage to buildings due to

earthquake, wind, and tornado. Environmental data are provided along with the program describing the seismic and wind activity for the entire continental United States, Alaska, and Hawaii. Historically based tornado activity for the continental United States is also included. With these data, the program will compute the ground velocity spectrum for any given building site in the country. Algorithms for computing damage are based on the assumption that the percentage of damage varies continuously with key response parameters. The forms of damage distribution curves as functions of response are also built into the program.

*1399 **DOT . . . Determination of Temperatures DETECT . . . Determination of Temperatures in Construction;** Program Number: 33-076; NSF/RA-762086; University of California, Department of Civil Engineering; Polivka RM, Wilson EL; June 1976; NSF Grant No. PFR 7720667

DOT is a finite element heat transfer analysis program for both linear and nonlinear two-dimensional planar and axisymmetric heat conduction problems. Material nonlinearities such as temperature-dependent conductivity and specific heat are considered as well as nonlinear radiation boundary conditions for the case of structures exposed to a fire environment. Structures to be analyzed may be composed of a number of different finite elements. Both the DOT and DETECT programs are capable of analyzing (a) time-dependent nodal temperatures and/or heat flux specifications; (b) convective surface heat transfer specifications where the convection coefficient may be temperature dependent and the environmental temperature can vary with time; and (c) time-dependent internal heat generation. Additionally, the DOT program can analyze nonlinear radiation boundary conditions where the environmental temperature may be time dependent. The programs are written FORTRAN IV with an in-core equation solver and dynamic allocation for all major arrays in blank COMMON.

*1400 **DRAIN 2D: EL9 and EL10-Hysteresis Models for Steel Members Subjected to Cyclic Buckling or Cyclic End Moments and Buckling;** Program Number: 49-0479; NSF/RA-780897; University of Michigan, Department of Civil Engineering; Jain AK, Goel SC; December 1978; NSF Grant No. PFR 7720667

Elements EL9 and EL10 are general purpose programs for steel members subjected to cyclic buckling, or cyclic end moment-buckling, respectively. EL9 incorporates the hysteresis behavior of primarily axially loaded steel bracing members. The hysteresis model accounts for increase in member length and reduction in compressive strength with number of cycles. EL10 is a combination of beam-column element (EL2) and buckling element (EL9). This element considers the interaction between the end moments and axial force in the beam-column component EL2, the axial force being determined by the buckling element EL9. In this formulation, the flexural stiffness is assumed to be independent of the axial force.

*1401 **DRAIN-2D . . . Inelastic Dynamic Response of Plane Structures;** Program Number: 14-875; NSF/RA-K-73-170; University of California, Department of Civil Engineering; Kanaan AE, Powell GH; September 1973; Revised August 1975; NSF Grant No. PFR 7720667

The program determines the dynamic response of inelastic two-dimensional structures of arbitrary configuration resulting from earthquake-type ground motions. Independent horizontal and vertical excitation may be specified, but out-of-phase support motions cannot be considered. Static loads may be applied to the structure prior to the application of the dynamic loading, but behavior under static load may be inelastic. The structure may be composed of elements of a variety of types, each having a different behavior pattern and yielding characteristics. Five different element types have been incorporated: truss; beam-column; shear (infill) panel; semi-rigid connection; and degrading stiffness R/C beam. The program is structured to permit new elements to be added with a relatively small amount of coding effort. It is written in FORTRAN IV with dynamic storage allocation for major arrays in blank COMMON.

*1402 **DRTABS (DRAIN-TABS) . . . Inelastic Earthquake Response of Three-Dimensional Buildings;** Program Number: 36-0677; NSF/RA-762087; University of California, Department of Civil Engineering; Guendelman R, Powell GH; October 1976; NSF Grant No. PFR 7720667

This program determines the inelastic dynamic response of three-dimensional buildings of essentially arbitrary configuration due to ground motions. Two independent horizontal motions plus vertical motion may be specified. Out-of-phase support motions cannot be considered. Static loads may be applied to the structure prior to the application of the dynamic loading, but the behavior under static load must be elastic. Five different element types have been incorporated in the program: (1) truss; (2) beam-column; (3) infill panel; (4) semi-rigid connection; and (5) beam with degrading stiffness. The program is written in FORTRAN IV, but is subdivided into overlays in order to reduce core storage requirements.

*1403 **EAD . . . Earthquake Analysis of Dams;** Program Number: 01-573; NSF/RA-K-70-008; University of California, Department of Civil Engineering; Chopra AK, Chakrabarti P; September 1970; NSF Grant No. PFR 7720667

EAD is a general program based on the finite element method of analysis of linearly elastic dam cross-sections subjected to earthquakes. It is applicable to the anal-

*For ordering information, see Appendix B.

ysis of concrete dams as well as earth dams. The program determines the elastic dynamic response (displacement, acceleration, and stress) of dams to earthquake ground motion. Both horizontal and vertical components of ground acceleration are included. Mode shapes and frequencies are also computed. Static effects of self-weight as well as hydrostatic pressure may be included. The program is written in FORTRAN IV. Core storage is dynamically allocated so that maximum problem size depends on the computer core storage capacity. The storage required for any particular problem depends on the number of nodes, number of elements and elements' connectivity (bandwidth of equilibrium equations).

*1404 **EADHI . . . Earthquake Analysis of Gravity Dams Including Hydrodynamic Interaction;** Program Number: 13-873; NSF/RA-K-73-171; University of California, Department of Civil Engineering; Chakrabarti P, Chopra AK; May 1973; NSF Grant No. PFR 7720667

This program determines the earthquake response of gravity dams including dynamic interaction effects of water in the reservoir. The problem is treated as two dimensional, considering horizontal and vertical components of earthquake ground motion. Material behavior is assumed to be linearly elastic. In the analysis the dam is represented as a finite element system, and water in the reservoir is treated as a continuum of infinite length in the upstream direction governed by the wave equation. The effects of the compressibility of water on the dynamic response are included. The analysis is performed in the frequency domain, first obtaining the frequency responses and then synthesizing them by Fast Fourier Transform procedures to obtain responses to arbitrary ground motion. The program is written in FORTRAN IV and was developed on a CDC 6400. It can be executed on other computers with minimal changes.

*1405 **EATSW . . . Earthquake Response of Axisymmetric Tower Structures Surrounded by Water;** Program Number: 17-274; NSF/RA-K-73-172; University of California, Department of Civil Engineering; Liaw C-Y, Chopra AK; October 1973; NSF Grant No. PFR 7720667

EATSW determines the elastic dynamic response of axisymmetric towers partially submerged in water to earthquake ground motion. It can evaluate the response to two perpendicular components of horizontal ground motion. The program is based on a sub-structure analysis procedure in which the tower is treated as an axisymmetric finite element system and the surrounding water as a continuum if the structure-water interface is cylindrical, but as a finite element system otherwise. Displacements of the tower are presented as a superposition of the first few mode shapes of the tower with no surrounding water. The terms associated with hydrodynamic interaction in the model equations of motion are determined by solving the Laplace equation, governing the dynamics of incompressible fluids, subject to appropriate boundary conditions. For cylindrical towers these solutions are obtained as explicit mathematical solutions of the boundary value problems; whereas they are obtained by the finite element method in cases of towers with non-cylindrical outside surface. The response to earthquake ground motion is determined by step-by-step integration of the equations of motion. The program is written in FORTRAN IV and was developed on a CDC 6400. It can be executed on other computers with minimal changes.

*1406 **EMOI . . . Extended Matrix Operation Interpreter;** Program Number: 34-04477; NSF/RA-771086; University of Colorado at Denver, Civil & Environmental Engineering Department; Mays JR; January 1977; NSF Grant No. PFR 7720667

EMOI is a major extension of the FORTRAN IV program SMIS which demonstrates the following characteristics: (1) An interpretive system should be usable by students with minimal knowledge of programming languages (BASIC, FORTRAN, etc.); (2) It should be used as a tool to accomplish step-by-step procedures leading to a complete solution. (3) SMIS maintains its use as a general matrix interpretive system but has commands which allow matrix operations peculiar to the area of structural analysis by the direct stiffness method (both static and dynamic loading); (4) The system is programmed such that additional symbolic commands could be easily added to the library as the need arises.

*1407 **EQRISK . . . Evaluation of Sites for Earthquake Risk;** Program Number: 43-1277; NSF/RA-762088; U.S. Geological Survey; McGuire RK; January 1976; NSF Grant No. PFR 7720667

EQRISK is a computer program for the evaluation of earthquake risk at chosen sites. Seismic events are considered as point sources; their occurrence in space is defined by the user. A variety of parameters may be used to quantify ground shaking, such as peak ground acceleration, velocity, displacement, Modified Mercalli intensity, spectral velocity, etc. An attenuation function must be specified by the user, and may be in analytical form or tabular form. Output gives annual risks (probabilities of equalizing or exceeding) for chosen values of the parameter values for pre-selected risk levels. Output is easily obtained for sites on a grid; thus the program is suitable for seismic mapping. Cartesian or longitude-latitude coordinates may be used. Several sets of information are required to run the program. The ground motion parameter must be determined, and values for risk evaluation must be specified.

*For ordering information, see Appendix B.

DIRECTORATE FOR ENGINEERING

Division of Civil and Environmental Engineering: Computer Programs

*1408 **ETABS . . . Extended Three-Dimensional Analysis of Building Systems;** Program Number: 24-675; NSF/RA-K-75-205; University of California, Department of Civil Engineering; Wilson EL, Hollings JP, Dovey HH; April 1975; NSF Grant No. PFR 7720667

ETABS is designed to perform linear structural analysis of frame and shear wall buildings subjected to both static and earthquake loadings. The building is idealized by a system of independent frame and shear wall elements interconnected by floor diaphragms which are rigid in their own plane. Three independent vertical and two lateral static loading conditions are possible. The static loads may be combined with a lateral earthquake input that is specified either as an acceleration spectrum response or as a ground acceleration record. Three dimensional mode shapes and frequencies are evaluated. The program is written in FORTRAN IV with dynamic storage allocation for major arrays in blank COMMON.

*1409 **EXCEMTANK . . . Response of Empty Cylindrical Ground Supported Liquid Storage Tank to Base Excitation;** Program Number: 28-476; NSF/RA-K-75-206; University of Massachusetts, Department of Civil Engineering; Shaaban SH, Nash WA; August 1975; NSF Grant No. PFR 7720667

The elastic response of an empty cylindrical tank with vertical axis and supported on a rigid base slab is developed for arbitrary horizontal slab excitation. The shell behavior is governed by the Sanders' small displacement relations. Solution is effected through employment of a finite element approach based upon ring-shaped elements extending from tank bottom to tank top. Two main programs are employed. The first is a free vibration program; it extracts eigenvalues and natural modes of the slab-supported tank. The second is a response program; it partitions the mass and stiffness matrices developed in the first program, then applies modal analysis after retrieving stored modes and associated frequencies from the first main program. The modal analysis leads to tanks response to either deterministic ground acceleration pulses or earthquake records.

*1410 **EXDOMTANK—Seismic Response of a Domed Cylindrical Liquid Storage Tank;** Program Number: 35-0880; NSF/RA-780899; University of Massachusetts, Department of Civil Engineering; Balendra T, Nash WA; May 1978; NSF Grant No. PFR 7720667

This system is a cylindrical storage tank, ground supported, covered by an axisymmetric dome, and filled within the cylindrical portion to an arbitrary depth with a perfect liquid. It is desired to determine the elastic response of the coupled elastic tank-liquid system to arbitrary horizontal excitation of the rigid base slab. The shell behavior is governed by linear small displacement relations. A solution requires a finite element approach based upon use of ring-shaped elements extending from the base of the cylindrical portion to the apex of the dome. Rectangular elements characterize the liquid. The bottom of the tank is assumed to be rigidly clamped to the base slab. Continuity is enforced between the top of the cylinder and the dome. Alternately, it is possible to consider a cylindrical tank having no dome. In that case, the tank top may have boundary conditions of simple support, complete fixity, or be free. Four separate programs are utilized to calculate the system response. They determine: (1) stiffness and mass matrices of the shell of revolution; (2) added mass of the fluid; (3) frequencies and mode shapes; and (4) nodal displacements, force, and moment resultants. The programs yield time-dependent values of significant displacements and stresses in tank and dome.

*1411 **FIRES-T3 . . . Fire Response of Structures—Thermal—Three Dimensional Version;** Program Number: 52-0979; NSF/RA-771087; University of California, Department of Civil Engineering; Iding R, Bresler B, Nizamuddin Z; September 1977; NSF Grant No. PFR 7720667

This program evaluates the temperature distribution history of structures in fire environments. There are options for fully three-dimensional solids, two-dimensional cross-sections, and structures in which heat flow is one-dimenstional. The program also permits the use of one-, two-, and three-dimensional elements in the same structure. Structures may consist of one material, or may be composites such as reinforced concrete. The heat flow problem is modeled in FIRES-T3 by the heat conduction boundary value problem. These equations are non-linear because of the temperature dependence of the thermal properties of structural materials and the heat transfer mechanisms associated with fire environments. The solution technique used in the program is a finite element method coupled with time-step integration.

*1412 **FTAP . . . Fault Tree Analysis Program;** Program Number: 47-0379; NSF/RA-790677; University of California, Operations Research Center; Willie R; March 1979; NSF Grant No. PFR 7720667

FTAP is a general purpose program for deriving minimal reliability cut and path set families from the fault tree for a complex system. The program is well-suited to nearly all fault tree applications. An input fault tree may specify the system state as any logical function of subsystem or component state variables or complements of these variables. FTAP offers the flexibility of several distinct methods of generating cut set families. It can also identify certain subsystems as system modules and provide a collection of minimal cut set families that essentially express the system state as a function of these modules' state variables. Another feature allows a useful subfamily to be obtained when the family of minimal cut

*For ordering information, see Appendix B.

sets or prime implicants is too large to be found in its entirety. Finally, the analyst can modify tne input fault tree in various ways by declaring state variables identically true or false. FTAP is written almost entirely in FORTRAN. Assembler routine packages are supplied for CDC 6600/7600 and IBM 360/370 series machines.

*1413 **GADFLEA . . . Analysis of Pore Pressure Generation and Dissipation During Cyclic or Earthquake Loading;** Program Number: 44-0676; NSF/RA-760089; University of California, Department of Civil Engineering; Booker JR, Rahman MS, Seed HB; October 1976; NSF Grant No. PFR 7720667

In this finite element program, the pore pressure generating effects of cyclic loading are incorporated into a dissipation analysis by the introduction of a source term, under one-dimensional conditions. GADFLEA has been used to analyze a wide range of problems such as (1) the generation and dissipation of pore pressure in horizontally stratified soil deposit subjected to earthquake loading, (2) the use of gravel drains to stablize potentially liquefiable soil deposits, (3) the generation and dissipation of pore pressure in earth and rock-fill dams subjected to earthquake loading, (4) the generation and dissipation of pore pressure in marine deposits subjected to wave action, and (5) the potential for liquefaction under off-shore structures subjected to storm loading.

*1414 **LASS2 . . . Liquefaction Analysis of Saturated Soil Deposits;** Program Number: 40-1077; NSF/RA-771088; University of Illinois at Urbana-Champaign; Department of Civil Engineering; Ghaboussi J, Dikmen SU; June 1977; NSF Grant No. PFR 7720667

LASS2 is for the analysis of seismic response and liquefaction of horizontally layered saturated solids. The saturated soil below water table is modeled as a coupled two phase medium with solid granular skeleton and pore water as the constituent materials. Coupling between these two phases is taken into account. The pore water is allowed to flow with respect to granular solid and this process is assumed to be governed by Darcy flow law with the coefficient of permeability as the material constant. Above the water table, soil is modeled as one phase solid. A nonlinear material model is used in the program which includes yielding, failure, volume change characteristics, cyclic effects and criteria for initial and final liquefaction. . Two different material models are used for the behavior of soil before and after initial liquefaction.

*1415 **LASS-III—Seismic Response and Liquefaction of Layered Ground Under Multi-Directional Shaking;** Program Number: 54-0780; NSF/RA-790678; University of Illinois at Urbana-Champaign; Ghaboussi J, Dikmen SU; July 1979; NSF Grant No. PFR 7720667

LASS-III is for analysis of seismic response and liquefaction of horizontally layered ground subjected to multi-directional shaking. The saturated sand below the water table is modeled as a coupled two phase medium. The two phases are the porous deformable granular solid and the pore water. A nonlinear material model is used to represent the behavior of sand under cyclic bi-axial shear stress. A vertical column of the horizontally layered ground is divided into a number of layer elements. At each nodal plane separating two adjacent layer elements there are four displacement degrees of freedom: three components of displacement of granular solid and the vertical displacement of pore water. The stress state for the solid portion consists of two horizontal shear stresses and effective pressure. Effective pressures at each element are monitored for initial liquefaction and complete liquefaction. When the liquefaction criterion is satisfied the element properties are modified accordingly. After the earthquake occurs, the program provides an option for analyzing dissipation of pore pressures.

*1416 **LAYER . . . Deconvolution of Surface Accelerograms for Horizontally Stratified Soil Layers;** Program Number: 22-275; NSF/RA-K-71-054; University of California; Rukos EA; May 1971; NSF Grant No. PFR 7720667

Stratified soil deposits can be idealized as one-dimensional wave systems when undergoing either horizontal or vertical motion. The direct computation of the ground surface accelerations given the input record (at bedrock or as an incoming wave from the underlying half space) is a well known procedure. It is the purpose of this program to solve the inverse problem, that is, the computation of the incoming earthquake accelerations from prescribed surface strong motion earthquake records. The soil model considers only shearing deformations and is restricted to horizontally stratified soil layers. Equations of free vitbration are integrated numerically to obtain the wave propagation effects. The accuracy of the numerical integration scheme is assessed by comparison of the numerically integrated response of an undamped system with the "exact" result obtained from the one-dimensional wave equation.

*1417 **LUSH2 . . . Complex Response Analysis of Soil-Structure Systems by the Finite Element Method;** Program Number: 21-874; NSF/RA-K-74-190; University of California, Department of Civil Engineering; Lysmer J, Udaka T, Seed HB, et al; July 1974; NSF Grant No. PFR 7720667

This program finds the complete response of a plane finite element model representing a soil-structure system. It differs from more conventional finite element programs in that it takes into account the strong nonlinear effects which occur in soil masses subjected to strong earthquake motions. This is achieved by a combination of an equivalent

*For ordering information, see Appendix B.

linear method and the complex response method. The latter method makes it possible to work with different damping in each element and to consider higher frequencies than most other methods of dynamic analysis. LUSH 2 is written in FORTRAN IV and has been test run on CDC 6400, CDC 6600, CDC 7600 and UNIVAC 1108 computers.

*1418 **MASH . . . Non-Linear Analysis of Vertically Propagating Shear Waves in Horizontally Layered Deposits;** Program Number: 51-0879; NSF/RA-780898; University of California, Department of Civil Engineering; Martin PP, Seed HB; October 1978; NSF Grant No. PFR 7720667

MASH is designed to solve the dynamic response of a deposit of horizontal soil layers. A deposit is discretized into a string of one-dimensional constant strain finite elements with masses lumped at the nodes. An implicit formulation of the time-stepping cubic inertia algorithm is used to integrate the equations of motion. This procedure has been found to be advantageous when used with non-linear materials. The soil material may be either visco-elastic, or non-linear with rate independent damping. The non-linear soil model incorporated in the program is the Davidenkov model, wherein stresses are expressed as functions of strains. Laboratory measurement of the variation of the secant modulus with cyclic strain amplitude defines the parameters used in the model. The program is written in FORTRAN IV.

*1419 **NONSAP . . . A Structural Analysis Program for Static and Dynamic Response of Nonlinear Systems;** Program Number: 18-474; NSF/RA-K-74-191; University of California, Department of Civil Engineering; Bathe KJ, Wilson EL, Iding RH; February 1974; NSF Grant No. PFR 7720667

NONSAP is a finite element structural analysis program for the static and dynamic response of nonlinear systems. The program is an in-core solver. Its capacity is essentially determined by the total number of degrees of freedom in the system. All structure matrices are stored in compacted form, i.e., only nonzero elements are processed. The system response is calculated using an incremental solution of the equations of equilibrium with the Wilson or Newmark time integration scheme. Before the time integration is carried out, the constant structure matrices, namely the linear effective stiffness matrix, the linear stiffness, mass and damping matrices, whichever applicable, and the load vectors are assembled and stored on low-speed storage. During the step-by-step solution the linear effective stiffness matrix is updated for the nonlinearities in the system. Therefore, only the nonlinearities are dealt with in the time integration. The structural systems to be analyzed may be composed of a number of different finite elements.

*For ordering information, see Appendix B.

*1420 **PSEQGN . . . Artificial Generation of Earthquake Accelerograms;** Program Number: 05-573; NSF/RA-K-69-004; University of California, Department of Civil Engineering; Ruiz P, Penzien J; March 1969; NSF Grant No. PFR 7720667

PSEQGN produces digitized records of acceleration, velocity, and displacement simulating those of earthquake ground motion. Random motion, having the required properties of white noise, is developed using a sequence of random numbers. A function to generate a random number sequence must be available. The random motion is modified by an intensity-time function to produce the bedrock motion. Surface motion is obtained by passing the bedrock motion through a second order linear filter. A parabolic base line correction is applied to the accelerogram to limit drift. PSEQGN is dimensioned to handle 3000 output values (acceleration, velocity, or displacement) per accelerogram. There is no limit to the number of accelerograms that can be generated.

*1421 **QUAD-4 . . . Seismic Response of Soil Structures;** Program Number: 15-1073; NSF/RA-K-73-173; University of California, Department of Civil Engineering; Idriss IM, Lysmer J, Hwang R, et al; July 1973; NSF Grant No. PFR 7720667

This program evaluates the seismic response of any soil deposit or earth structure using a variable damping finite element procedure. This analytical procedure permits the use of strain-dependent modulus and damping values for each element in the finite element representation of a deposit. It is an improved means for the response analysis of soil deposits having considerable geometric variations (such as banks and earth dams) and having greatly varying material characteristics (such as a soil-structure system). In addition, the formulation of the procedure allows incorporation of nonlinear stress-strain relationships through the use of equivalent linear and strain-dependent material properties. The equations of motion are solved by a direct step-by-step numerical method.

*1422 **RCCOLA . . . Reinforced Concrete Column Analysis;** Program Number: 45-0578; NSF/RA-771089; University of California, Department of Civil Engineering; Mahin SA; August 1977; NSF Grant No. PFR 7720667

RCCOLA will evaluate the general flexural characteristics of reinforced concrete cross-sections subjected to axial forces and uniaxial bending moments. The constitutive relationships considered for the concrete and reinforcement are general, single-valued functions of strain. Plane sections are assumed to remain plane after deformation, and bond slip between the concrete and the reinforcement is disregarded. These assumptions permit the uniaxial flexural characteristics of the monotonically loaded regions of the reinforced concrete members to be estimated. An analytical

procedure based on these assumptions is used (1) to solve the equilibrium equations for the bending moment and neutral axis location given the axial load acting on the section and the compression strain at its extreme compression fiber, (2) to evaluate the energy absorption characteristics of the critical region, and (3) to assess the effect of the shear on the member's ability to develop its flexural capacity. The program is written in FORTRAN IV.

*1423 **SAKE ... Inelastic Analysis of R/C Frames to Earthquakes;** Program Number: 23-375; NSF/RA-K-74-192; University of Illinois; Otani S; November 1974; NSF Grant No. PFR 7720667

SAKE was developed to analyze the inelastic behavior of a multi-story, reinforced concrete frame structure subjected to an intense earthquake motion in one horizontal direction. An equivalent spring model is used in the program to simulate the inelastic flexural deformation of a member. The analytical model recognizes stiffness changes caused by cracking of the concrete, yielding of the reinforcement, and stress reversals. Hysteresis rules for the flexural behavior of a reinforced concrete member under load reversals are adopted after Takeda. In addition to inelastic flexural deformation, a deformation caused by bond slip of the longitudinal reinforcement within a joint core is considered, represented by another inelastic rotational spring. Step-by-step numerical integration procedures are used to obtain the building response.

*1424 **SAP IV ... A Structural Analysis Program for Static and Dynamic Response of Linear Systems;** Program Number: 11-474; NSF/RA-K-73-174; University of California, Department of Civil Engineering; Bathe KJ, Wilson EL, Peterson FE; June 1973; Revised April 1974; NSF Grant No. PFR 7720667

SAP IV is a finite element structural analysis program for the static and dynamic response of linear three-dimensional systems. The program is written to analyze structures which are idealized by combinations of structural element types. The capacity of the problem depends mainly on the number of finite element nodal points in the system. There is no restriction on the number of elements, the number of load-cases, and the number or bandwidth of the equations to be solved. In a dynamic analysis the options are (1) frequency calculations only, (2) frequency calculations followed by response history analysis, (3) frequency calculations followed by response spectrum analysis, and (4) response history analysis using step-by-step direct integration. Despite large system capacity, no loss in efficiency is encountered in solving smaller problems. The report describes the logical construction of the program, the dynamic high speed storage allocation, the analysis capabilities, the finite element library and the numerical techniques used. Sample analyses with problem solutions are provided. The program is written in FORTRAN IV.

*1425 **SEAWAVE ... A Model of Tsunami Generation and Propagation;** Program Number: 30-976; NSF/RA-K-74-193; Tetra Tech, Inc.; Brandsma M; 1974; Revised July 1976; NSF Grant No. PFR 7720667

SEAWAVE is a code which performs finite difference solutions of the long-wave equations in spherical coordinates on a variable depth bathymetry. The program was designed to model the tsunami resulting from the instantaneous vertical displacement of the sea-floor caused by an earthquake. SEAWAVE can be easily applied to any problem where the surface of a water body of variable depth is deformed as an initial condition. Matched impedance boundary conditions are applied to any open boundaries the user may specify. The program is written in FORTRAN IV and was developed on a CDC 6600 computer. It has been used extensively on CDC 7600 computers.

*1426 **SHAKE ... Earthquake Response Analysis of Horizontally Layered Sites;** Program Number: 12-773; NSF/RA-K-72-163; University of California; Schnabel PB, Lysmer J, Seed HB; December 1972; NSF Grant No. PFR 7720667

SHAKE computes the response in a horizontally layered soil rock system subjected to transient, vertical traveling shear waves. The method is based on Kanai's solution to the wave equation and the Fast Fourier Transform algorithm. The motion used as the basis for the analysis can be applied to any layer in the system. Systems with an elastic base and with variable damping in each layer can be analyzed. Equivalent linear soil properties are used with an iterative procedure to obtain soil properties compatible with the strains developed in each layer. The program was developed on a CDC 6400 computer using FORTRAN IV.

*1427 **SHOCHU ... Nonlinear Response Spectra for Probabilistic Seismic Design and Damage Assessment of Reinforced Concrete Structures;** Program Number: 42-1277; NSF/RA-K-75-207; Chiba University, Japan, Architectural Engineering, University of California, Berkeley, Department of Civil Engineering; Murakami M, Penzien J; November 1975; NSF Grant No. PFR 7720667

This program is a modified version of PSEQGN. It generates artificial earthquake accelerograms and nonlinear response spectra. A single degree of freedom model with a linear viscous damper and a nonlinear hysteretic spring is used to represent a low rise reinforced concrete building typical of a school building. Two types of nonlinear models are contained in the program: (1) an "origin-oriented" model, which represents a structure which will fail primarily in shear, and (2) a trilinear stiffness degrading model, which will fail

*For ordering information, see Appendix B.

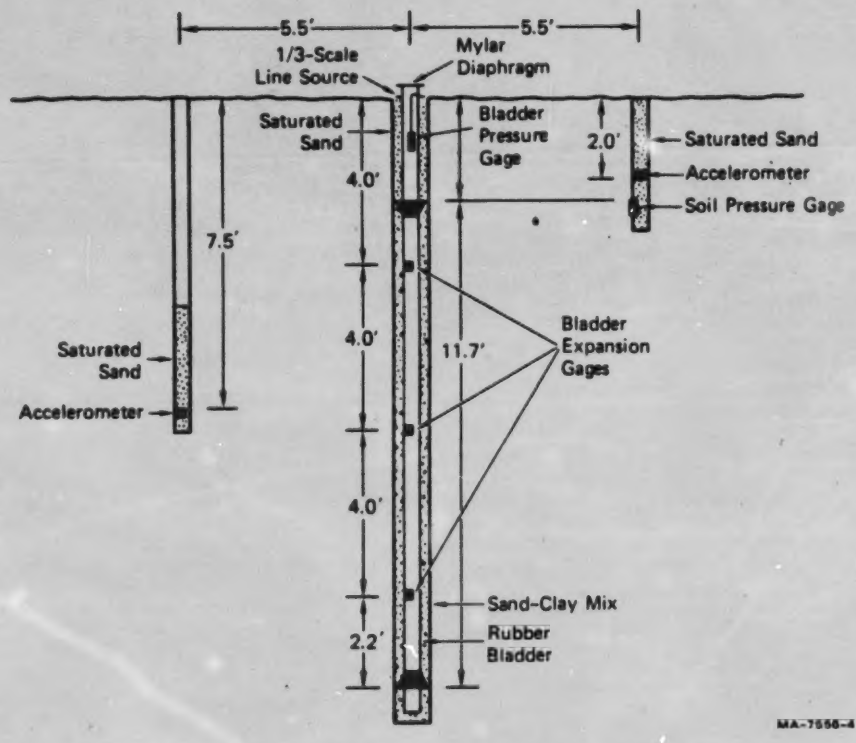

FIGURE 5 SCHEMATIC OF 4-IN.-DIAMETER LINE SOURCE IN SOIL

See Entry 1425

primarily in flexure. Various strength properties are prescribed for these models in terms of initial stiffness, cracking strength, and damping. Nonstationary filtered white noise is used to generate the artificial earthquake accelerogram. The structural model is subjected to the artificial earthquake and its time history calculated.

*1428 **SHORE-II . . . Shell of Revolution Finite Element Program—Static Case;** Program Number: 26-776; NSF/RA-K-73-175; Washington University; Gould PL, Brombolich LJ, Basu PK; November 1973; Revised March 1975; NSF Grant No. PFR 7720667

SHORE-II is a finite element program for the linear analysis of arbitrarily loaded thin elastic shells of revolution in the static regime. The meridional curve of the shell may have any quadratic shape including the case with closed end. The material of the shell may be single or multi-layer isotropic or orthotropic. Also, framed structures which follow the form of a surface of revolution, and axisymmetric plates can be analyzed. The shell is discretized by a series of high precision curved rotational elements and special cap elements. The maximum number of elements is limited to fifty. Discontinuous meridian curves are permissible. Loading conditions include concentrated line loads, distributed loads, and thermal loads. All loads (both thermal and mechanical) which are asymmetric are required to be expanded in Fourier harmonics. The program is written in FORTRAN IV language.

*1429 **SHORE-III . . . Shell of Revolution Finite Element Program;** Program Number: 41-0480; NSF/RA-K-75-210; Washington University; Basu PK, Gould PL; November 1975; NSF Grant No. PFR 7720667

SHORE-III is a finite element program for the linear static and dynamic analysis of arbitrarily loaded thin-to-moderately-thick elastic shells of revolution. The meridional curve of the shell may have any quadratic shape including the closed-end case. The material of the shell may be isotropic, or simple or multi-layer orthotropic. The shell may have discrete supports in the form of a framework of linear members with various end conditions and arrangements. Such a framework may also be located at any other level excepting the top. Also, framed structures which follow the form of a surface of revolution, and axisymmetric plates can be analyzed. The shell is discretized by a series of high precision curved rotational elements and special cap elements. Discontinuous meridian curves are permissible. The thickness of an element may vary linearly along the meridian. Loading conditions include concentrated line loads, distributed loads, and thermal loads. All loads which are asymmetric are required to be expanded in Fourier harmonics. Nonzero nodal displacements can also be prescribed. In the case of dynamic analysis, apart from the above loading cases, the effect of the base accelerations due to earthquake can be considered. The program is written in the FORTRAN IV language.

*1430 **SIMQKE . . . Simulation of Earthquake Ground Motions;** Program Number: 39-0777; NSF/RA-K-69-005; Massachusetts Institute of Technology, Department of Civil Engineering; Vanmarcke EH; Cornell CA, Gasparine DA, et al; August 1969, last revision September 1976, NSF Grant No. PFR 7720667

SIMQKE generates statistically independent accelerograms, performs a base line correlation on the generated motions to ensure zero final ground velocity, and calculates response spectra. One of the options of the program is to generate ground motions whose response spectra "match," or are compatible with, a set of specified smooth response spectra. The basis for the spectrum-compatible motion generation is the relationship between the response spectrum values for arbitrary damping and the "expected" Fourier amplitudes of the ground motion. Earthquakes are synthesized by superimposing sinusoidal components with pseudo-random phase angles, and by multiplying the resulting stationary trace by a user-specified function representing the variation of ground motion intensity with time. The program also has the capability to adjust, by iteration, the ordinates of the spectral density function to improve the agreement between computed and specified response spectra.

*1431 **SOLID SAP . . . Static Analysis Program for Three Dimensional Solid Structures;** Program Number: 02-573; NSF/RA-K-71-055; University of California, Department of Civil Engineering; Wilson EL; September 1971; Revised December 1972; NSF Grant No. PFR 7720667

SOLID SAP or SSAP is designed to perform static, linear, elastic analyses of three dimensional structural systems. The program has flexibility of application to structures which contain combinations of structural element types. The capacity of the program depends mainly on the number of joints in the system. There is practically no restriction on the number of elements, number of load cases, or the "bandwith" of the equations to be solved. Despite large system capacity, no efficiency loss is encountered in solving smaller problems. The report contains a discussion of the use of incompatible displacement nodes with solid elements and the use of the static condensation algorithm. A brief discussion of each element type is also given. SSAP is machine independent and coded in FORTRAN IV.

*1432 **SPECEQ/SPECUQ . . . Generation of Response Spectra Digitized at Equal/Unequal Time Intervals;** Program Number: 08-573; NSF/RA-K-68-007; California Institute of Technology; Nigam NC; Jennings PC; 1968; NSF Grant No. PFR 7720667

*For ordering information, see Appendix B.

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These programs compute response spectra from earthquake accelerograms digitized at equal (SPECEQ) or unequal (SPECUQ) time intervals. The generated response spectra represent the maximum responses of a damped single degree of freedom system to the specified earthquake ground acceleration. An exact analytical solution to the governing differential equation is used in the computation for successive linear segments of the excitation. The programs are written in FORTRAN IV and are dimensioned to handle up to 5 damping values, 50 points per spectrum and 3000 ground acceleration values.

*1433 **SPECTR . . . Spectra Response Analysis;** Program Number: 08-573; NSF/RA-K-72-164; Dames and Moore; 1972; NSF Grant No. PFR 7720667

SPECTR evaluates dynamic response spectra at various periods and presents the results as a log-log plot. On the basis of a given time-acceleration record, the program numerically integrates the normal convolution time integral for various natural periods and desired damping ratios. Relative displacements, relative and pseudo-relative velocities, and absolute and pseudo-absolute accelerations are computed for natural periods from 0.01 to 100 seconds. Three measures of spectral intensity are computed. A printer plot of desired damping ratios of the pseudo-relative velocity versus natural period is presented on a 2 by 2 inch log-log grid. SPECTR is written in FORTRAN IV and is dimensioned to handle an unlimited number of acceleration-time histories. A maximum of 6000 acceleration values at constant time intervals in each time-history record is allowed. Up to five different damping ratios can be handled in a single computer run.

*1434 **STABL . . . Analysis of General Slope Stability Problems;** Program Number: 27-0677; NSF/RA-K-75-208; Purdue University; Siegel RA, Boutrup E; June 1975, Revised June 1977; NSF Grant No. PFR 7720667

STABL is a computer program for the general solution of slope stability problems by a two-dimensional limiting equilibrium method. The calculation of the factor of safety against instability of a slope is performed by a method of slices in an adaptation of the Modified Bishop method. It allows the analysis of trial failure surfaces other than those of circular shape. STABL features unique random techniques for general potential failure surfaces for subsequent determination of the more critical surfaces and their corresponding safety factors. One technique generates circular surfaces; another, surfaces of sliding block character; and, a third, more general irregular surfaces of random shape. The means for defining a specific trial failure surface and analyzing it are also provided. The program can handle slope profiles having multiple slope ground surfaces. Any arrangement of subsurface soil types having different soil properties can be specified. Pore pressures may be related to a steady state flow domain, related to the overburden, or specified within zones. Surcharge boundary loads and pseudo-static earthquake loadings are also considered. The program has been written in FORTRAN IV.

*1435 **SUBWALL . . . Practical Elastic Analysis and Design of R/C Structural Walls Using Finite Elements;** Program Number: 35-0577; NSF/RA-771090; University of California, Department of Civil Engineering; Le DQ, Popov EP; March 1977; NSF Grant No. PFR 7720667

SUBWALL is a special purpose finite element program for the linear structural analysis and design of complex reinforced concrete walls subjected to arbitrary in-plane static loadings. A substructuring technique is implemented along with several user's options which contribute to computational efficiency and economy. Large structural walls with multiple openings, nonplanar coupled walls, and staggered wall beam systems can be analyzed. Openings and offsets in structural walls are represented by special "hole" elements having no structural stiffness. The program employs both the "Melosh" finite element, based upon imposing a displacement field over the element, and the "Turner-Clough" element, based upon imposing a stress field over the element. Boundary conditions of the structural wall can be specified easily. Provision is made to allow the user to state whether an entire side of the wall is a line of symmetry or antisymmetry, a rigidly restrained side, or a free side. Other support conditions can be specified at any single location such as initial displacement, elastic spring, or roller. Solutions for different types of loading conditions are available.

*1436 **TABS 77 . . . Three-Dimensional Analysis of Building Systems;** Program Number: 04-0177; NSF/RA-K-72-165; University of California, Department of Civil Engineering; Wilson EL, Dovey HH; December 1972; NSF Grant No. PFR 7720667

TABS is designed to perform linear structural analysis of frame and shear wall buildings subjected to both static and earthquake loadings. The building is idealized by a system of independent frame and shear wall elements interconnected by floor diaphragms which are rigid in their own plane. Bending, axial, and shearing deformations are included within each column. Beams and girders may be nonprismatic, and bending and shearing deformations are included. Special panel elements allow discontinuous shear walls to be modelled. Finite column and beam widths are included in the formulation. Nonsymmetrical, nonrectangular buildings that have frames and shear walls located arbitrarily in

*For ordering information, see Appendix B.

plan can be considered. Axial deformatons of common column lines of different frames are treated as uncoupled by the program. Three independent vertical and two lateral static loading conditions are possible. The static loads may be combined with a lateral earthquake input that is specified either as an acceleration spectrum response or as a ground acceleration record. Three dimensional mode shapes and frequencies are evaluated. The program is written in FORTRAN IV with dynamic storage allocation for major arrays in blank COMMON.

*1437 **TABS 80 . . . Three Dimensional Analysis of Building Systems;** Program Number: 56-0880; NSF/RA-800489; University of California, Department of Civil Engineering; Computers/Structures International; Dovey HH, Wilson EL, Habibullah A; June 1980; NSF Grant No. PFR 7720667

TABS 80 is an enhanced version of TABS, a computer program for the static and dynamic linear analysis of multistory frame and shear wall buildings. It is intended to supersede XTABS and TABS 77. A building is idealized as an assemblage of vertical independent frame and shear wall systems interconnected by horizontal floor diaphragms, rigid in their own plane. The frame and shear wall systems must be of basically rectangular geometry. A special shear panel element enables modeling of discontinuous shear walls and shear walls with arbitrary openings. A diagonal bracing element may be used to model braced frames. The column, shear panel, and diagonal formulations include the effects of bending, axial, and shear deformations. Effects of the finite dimensions of the beams and columns on the stiffness of a frame or shear wall systems are automatically included. The building may be unsymmetrical and non-rectangular in plan. Torsional behavior and interstory compatibility are accurately reflected in the results. Five static load conditions may be combined in any ratio to each other or to a lateral dynamic earthquake input, specified as a time-dependent ground acceleration or as an acceleration response spectrum. Three dimensional mode shapes and frequencies are evaluated.

*1438 **TANKFREQ . . . National Frequencies of Cylindrical Liquid Storage Containers;** Program Number: 29-576; NSF/RE-K-75-209; University of Massachusetts, Department of Civil Engineering; Mouzakis T; Nash WA; Colonell JM, et al; June 1975; NSF Grant No. PFR 7720667

This program is used to determine the natural frequencies and associated mode shapes of a right circular, elastic, cylindrical shell filled to an arbitrary depth with an incompressible, inviscid liquid. The shell, supported on a rigid base slab, is considered to undergo small deformations characterized by the Flugge equations. Liquid motion is represented by the Laplace equation and the Bernoulli equation expressed in terms of velocity potential. Compatibility conditions between the elastic tank wall and the liquid are enforced through equality of radial displacements of liquid and shell at the tank wall. Linearized liquid-free surface conditions are also considered. It is assumed that the moving liquid does not touch any top on the tank. Shell boundary conditions corresponding to complete fixity, simple support, and a free end are permitted at both tank bottom and tank top. Series solutions to the governing shell dynamics equations are found and represented in a form suitable for enforcement of any of these boundary conditions at tank base or tank top. This leads to the governing frequency equation whose solution is programmed. The program is presented in two parts, the first applicable to empty tanks, the second applicable to tanks filled to an arbitrary depth with liquid.

*1439 **TIMES . . . Times Series Analysis and Forecasting;** Program Number: 48-0177; NSF/RA-771091; Ohio State University; University of California, Operations Research Center; Pack D, Willie R; January 1977; NSF Grant No. PFR 7720667

TIMES is an integrated system of FORTRAN subroutines for time series analysis and forecasting. It is a tool for investigating both the structure of a single time series and the relationship between a pair of series. The system is based on a library of FORTRAN subroutines and designed for analysis of time series data. These routines perform modelling of a single times series or transfer function modelling with a single input series. The library has been extended to include a spectral package and a user-oriented control program. In addition, the original subroutine for plotting on a line printer has been replaced by more sophisticated printer routines that enhance and simplify graphical output. The TIMES source code corresponds very nearly to ANSI FORTRAN.

*1440 **ULARC . . . Small Displacements Elasto-Plastic Analysis of Plane Frames;** Program Number: 07-573; NSF/RA-K-72-166; University of California, Department of Civil Engineering; Sudhakar A, Powell GH, Orr G, et al; 1972; NSF Grant No. PFR 7720667

This program computes the node displacements, member forces, support reactions, plastic hinge rotations, and rigid-plastic collapse loads for plane frames of arbitrary shape subjected to static joint loads and support settlements. The program is applicable to low-rise frames of steel or reinforced concrete. Large displacement (P-Δ) effects are ignored. Nonproportional loading, including reversed loading, is permitted. The members may be of non-uniform stiffness and strength. Dimension statements limit the program to frames with no more than 50 nodes, 10 supported nodes, 15 different member shapes, 20 different cross-section strengths and 100 members. In addition, the storage occupied by the structure stiffness matrix may not exceed 3000 locations. However, the capacity can be expanded easily.

*For ordering information, see Appendix B.

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1441 **Algorithmic Analysis of a Markovian Model for a System with Batch and Interactive Jobs, Interim Report;** NSF/RA-800394; University of Delaware, Applied Mathematics Institute; Colard JP, Latouche G; March 1980; NSF Grant No. ENG 7908351, NTIS Order No.ADA 086711/9/NKS

A computer system serving both batch and interactive jobs is modeled as a single server queue, with an infinite source of ordinary customers and a finite source of priority customers. The stability condition and the stationary probability distribution are determined. For a stable system, it is shown how the distribution and moments of the waiting time, the sojourn time, the completion time, and the busy period, may be efficiently computed. (Author Abstract)

Note: This report is available in microfiche form only.

1442 **Asymptotic Unbounded Root Loci by the Singular Value Decomposition;** NSF/RA-790506; University of California at Berkeley, Department of Electrical Engineering and Computer Science and the Electronics Research Laboratory; Sastry SS, Desoer CA; 1979; 52 p; NSF Grant No. ENG 7684522; NTIS Order No. PB80-222490/NKS

The asymptotic behavior of the closed-loop eigenvalues (root loci) of a strictly proper linear time-invariant control system as the loop gain goes to infinity is studied. Basic properties of the singular value decomposition are introduced and then used to obtain formulas for the asymptotic values, as the loop gain goes to infinity, of the unbounded (with loop gain) root loci. The geometric interpretation of these formulas is developed and a numerically sound way of computing them is proposed. To obtain complete asymptotes of the unbounded root loci, perturbation techniques are used under mild assumptions. Necessary and sufficient conditions for the closed-loop exponential stability of a strictly proper linear time-invariant system under arbitrarily high feedback gain are derived by using these calculations. This is the generalization to the multi-input, multi-output of a well-known result for single-input, single-output systems.

1443 **Automatic Parameterization of Vocal Cord Motion from Ultra High Speed Films;** NSF/RA-800181; University of Florida, Departments of Electrical Engineering and Speech; Childers DG, Mott JS, Moore GP; 1980; NSF Grant No. PFR 7816965

Development of a system to measure parameters of the vibratory patterns of vocal cords from ultra high speed (approximately 5000 frames/sec) laryngeal films is reported. The objective of this research is to contribute data relevant to a theory of vocal cord motion and to develop aids for the hearing impaired. Image enhancement is achieved via image subtraction to remove artifacts and general background in the image. The glottal boundary is outlined with an adaptive window "bug" which traces the boundary of the glottis. Once the glottal boundary is estimated, the following parameters are measured: glottal area, glottal width at several points, glottal length, glottal perimeter, and velocity of vocal cord motion at several points.

Note: Published in IEEE International Conference on Acoustics, Speech and Signal Processing, Proceedings, Volume 1, April 1980.

1444 **Compensation for Diffraction in SAW Filters;** NSF/RA-790584; University of California, Department of Electrical and Computer Engineering; Savage EB, Matthaei GL; 1979; NSF Grant No. ENG 7728526

Serious diffraction-induced errors in the response of a SAW transversal filter can be reduced by corrections in the filter tap strengths and positions. Previously, tap perturbations were obtained using calculations made at the center frequency only. Recent fast methods for the calculation of Fresnal diffraction, assuming "parabolic" anisotropy, make iterative algorithms practical for optimizing the response. These methods are used in an iterative correction method which improves the frequency response by matching bandlimited responses in the time domain. Trial example designs which initially had severe errors due to diffraction are greatly improved by corrections obtained using this algorithm, whereas the degree of correction achieved using the center frequency method is much less. Both tap position and amplitude corrections are found to be necessary.

Note: Published in 1979 Ultrasonics Symposium Proceedings, IEEE.

1445 **Computerized Parameterization of Laryngeal Function from Images;** NSF/RA-800180; University of Florida, College of Engineering; Mott JS; 1980; 88 p; NSF Grant No. PFR 7816965; NTIS Order No. PB81-109977/NKS

A semiautomated system using digital image processing techniques to measure quantitative parameters from ultra high speed laryngeal films was implemented. The method described is an improved modification of a recent digital image processing technique. This system (LFAS) measures glottal area, length, perimeter, width, and vocal cord velocity. It was designed to measure these parameters in less time, with less operator intervention, and with equal or better accuracy than other existing methods. The system is compared to the planimeter, sonic pen, and video threshold methods of analyzing laryngeal films. Results show that the system operates well on films of low frequency utterances, but poorly on films of higher frequency utter-

ances because of constraints on digital resolution. The system speed is shown to be relatively slow, but this is offset by the number of parameters that it can measure. The automated erd detector has reduced operator intervention, though added editing options have eliminated any processing time that was saved. Though the LFAS is relatively slow, it can extract much more information from laryngeal films than other existing methods.

1446 **Development of a Micro-Solenoid Operated Braille Display Cell;** NSF/RA-800177; Universal Textile Machine Corporation; Blanco EE; June 1980; 56 p; NSF Grant No. PFR 7917730; NTIS Order No. PB81-110215/NKS

Investigated is a braille display letter unit capable of fitting into standard letter and line spacings and controlled electrically from a magnetic tape cassette. A prototype model composed of 140 components enclosed in a metallic shell the size of the little finger was built and tested successfully. It is capable of very fast cycling rates and provides a "feel" almost identical to that of "hardcopy" embossed braille. Vertically moving braille stimulators are driven by six micro-solenoids embodying a combination of leakage-flux and tapered-plunger principles and providing ideal force-stroke characteristics with minimal power consumption. Once energized, the stimulators remain in the display mode without drawing power, held by tiny latches that jam the solenoid stems and resist finger forces until released. This unit makes it possible to display refreshable braille in multiple lines at standard spacing in scientific instruments, computer readouts, word processing output systems, and the TSPS blind telephone operator's system.

1447 **Energy and Momentum Conservation Requirements for Electron Interactions with Electromagnetic Radiation;** NSF/RA-790589; Stanford University; Pantell RH; 1979; 13 p; NSF Grant No. ENG 7901743

This study considers the amount of energy exchange that can result from various mechanisms for obtaining interactions between electrons and radiation. The mechanisms are based on energy and momentum conservation and conformity with relevant dispersion characteristics. These conditions determine what is or isn't possible regarding schemes for amplification of waves or acceleration of electrons. As an example, if electron bunching is to occur, as in a klystron, then the energy delivered to the particle beam from the wave must be on the order of or greater than the random energy on the beam.

Note: Published in Physics of Quantum Electronics, Volume 7, 1979.

1448 **Enlarging the Region of Convergence of Newton's Method for Constrained Optimization;** NSF/RA-800146; Massachusetts Institute of Technology. Laboratory for Information and Decision Systems; Bertsekas DP; March 1980; 41 p; NSF Grant No. ENG 7906332; NTIS Order No. PB80-219215/NKS

Newton's method for solving the system of necessary optimality conditions of optimization problems with equality and inequality constraints is considered. The principal drawbacks of the method are the need for a good starting point, the inability to distinguish between local maxima and local minima, and, when inequality constraints are present, the necessity to solve a quadratic programming problem at each iteration. Extensions to inequality contraints are based on the use of penalty functions by converting inequality constraints to equality constraints through the use of squared slack variables. The resulting Newton-like methods do not require solution of quadratic programming subproblems but rather employ systems of linear equations similar to those arising in the quality constrained case and involving only the active and nearly active constraints. It is shown that there is a close relationship between the class of penalty functions of Di Pillo and Grippo and the class of Fletcher. It is also shown that the region of convergence of a variation of Newton's method can be enlarged by making use of one of Fletcher's penalty functions.

1449 **Frequency Domain Design of Multivariable Control Systems, Final Report (June 1, 1977—November 30, 1979);** NSF/RA-800143; Rice University; Pearson JB, February 1980; 11 p; NSF Grant No. ENG 7704119; NTIS Order No. PB81-103541/NKS

The main objectives of this project were to use frequency domain formulations to establish new theoretical results in multivariable control system synthesis and to obtain computational algorithms to aid in the implementation of the theory for control system design. A general formulation and solution was obtained to the linear multivariable regular problem, a problem of considerable practical importance, and two new algorithms were developed for computing with polynomial matrices. These algorithms, one for factoring polynomial matrices and one for computing unimodular matrices and their inverses, are of general interest in linear system theory and are not restricted only to control system applications. It was concluded that frequency domain formulations of linear multivariable control problems are a more natural formulation than the state-space formulations of the past and the computational problems which initially appeared so formidable will soon become routine. A technical description of the project and results are presented.

1450 **Functional Expansion Approach to the Solution of Nonlinear Feedback Problems;** NSF/RA-790508; Massachusetts Institute of Technology. Laboratory for Information and Decision Systems; Singh RNP, Johnson TL; August

1979; 24 p; NSF Grant No. ENG 7705200; NTIS Order No. AD-A077408/NKS

The application of a functional expansion technique introduced by Bellman to the determination of nonlinear optimal control laws is described. The method is shown to have interesting consequences when applied to the solution of the Hamilton-Jacobi-Bellman partial differential equation for particular optimal control problems. For a certain class of "smooth" control problems, the convergence of the expansion technique may be improved by use of a non-linear rather than linear auxiliary equation which is based on a known cost-to-go function for an associated "linear-quadratic" optimal control problem. Analytical examples are presented which provide an indication of the nature of convergence of the method. The class of problems where the technique is potentially most useful is delineated. This technique is distinguished from power series methods which, while more commonly applied, tend to yield inferior solutions to highly nonlinear or time-varying problems.

1451 **Hearing Aids for Spatial Perception and Localization, Phase I Report;** NSF/RA-800086; Vibrasound Research Corporation; Kuhn GF; March 1980; 53 p; NSF Grant No. PFR 7917067; NTIS Order No. PB80-212541/NKS

Analytical and numerical estimations of the localization cues available to hearing-aided listeners are presented. The interaural time differences are predicted on the basis of (low-frequency) diffraction theory for a rigid sphere and rigid cylinder for the head and torso, respectively. The interaural time difference function is bivalued when the hearing aids are placed assymetrically, relative to the median plane. This bivaluedness causes localization confusion. The high frequency localization cues are the interaural level differences and the spectrum in the azimuthal and vertical median planes, respectively. Fourier coefficients for the ILD in the horizontal plane and for the vertical median-plane directivity were determined numerically. Thus, the azimuthal and vertical localization cues can be expressed via a Fourier series.

1452 **Generalized Inverses and Their Application to Applied Probability Problems, Technical Report;** NSF/RA-800399; Virginia Polytechnic Institute and State University, Department of Industrial Engineering and Operations Research; Hunter JJ; May 1980; 59 p; NSF Grant No. ENG 7722757; NTIS Order No. ADA088999/8/NKS

The main aim of this paper is to examine the applicability of generalized inverses to a wide variety of problems in applied probability where a Markov chain is present either directly or indirectly through some form of imbedding. By characterizing all generalized inverses of I-P, where P is the transition matrix of a finite irreducible discrete time Markov chain, one is able to obtain general procedures for finding stationary distributions, moments of the first passage time distributions and asymptotic forms for the moments of the occupation time random variables. It is shown that all known explicit methods for examining these problems can be expressed in this generalized inverse framework. More generally, in the context of a Markov renewal process setting, the aforementioned problems are also examined using generalized inverses of I-P. As a special case, Markov chains in continuous time are considered, and show that the generalized inverse technique can be applied directly to the infinitesimal generator of the process, instead of to I-P, where P is the transition matrix of the discrete time jump Markov chain. (Author Abstract)

1453 **Individual Versus Social Optimization in Commuter Route Choice, Technical Report;** NSF/RA-800402; Stanford University, Department of Operations Research; Bell CE; January 1980; 24 p; NSF Grant No. ENG 7514847; NTIS Order No. ADA088016/1/NKS

Each of N customers must select one of K commuter routes daily. Each commuter route is represented as a series of M/D/1 queueing stations with fixed travel times between stations. In the basic model, all customers arrive at the start of their selected route simultaneously; results which are optimal for the basic model are shown to be nearly optimal under a variety of more realistic arrival assumptions. (Author Abstract)

1454 **Investigation of PVF2 as a Tactile Stimulator for the Optacon, Final Report;** NSF/RA-800085; Telesensory Systems, Inc.; Tetzlaff JF; March 1980; 14 p; NSF Grant No. PFR 7918431; NTIS Order No. PB80-221815/NKS

The objectives of this study were to fabricate individual polyvinylidene fluoride cylindrical tactile stimulators and to place these cylinders in a small 2 x 3 array. In spite of material problems, a working Braille cell was constructed which exhibited the correct vibration levels for its elements. Cylinders 5 cm long were wound out of 30 micrometer-thick material and assembled in a 2 x 3 array in the configuration of a Braille cell. Satisfactory methods were found for rolling the polyvinylidene fluoride films, etching the electrodes, and mounting and electrically bonding the cylinders. Correct electrical excitation levels were determined. Using the methods developed in this research, it should be possible to research, design, and develop a polyvinylidene fluoride tactile screen which would enable one-handed operation of the Optacon. This feature would enlarge the range of tasks with which a blind person could use the Optacon, allowing higher effectiveness in a job setting.

1455 **Low-Cost, High-Performance Speech Recognizer for the Handicapped;** NSF/RA-800176; Threshold Technology Inc.; Scott PB, Welch JR; May 1980; 48 p; NSF Grant

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No. PFR 7617038; NTIS Order No. PB81-112948/NKS

This research involved a study of techniques whereby existing high-quality speech recognition devices can be modified and/or adapted so that they can eventually be produced at a low cost while maintaining their high performance. A complete review was made of the present techniques upon which speech recognition systems are based. A number of experiments were conducted to determine the feasibility of reducing the number of recognition features in the Threshold Technology, Inc. system, as well as simplifying the final digital classification processing. Simplification of features and processing could result in decreasing the memory requirements and could relax specifications for the classifier. If a low-cost microprocessor can be substituted for the minicomputer of the present system, a significant cost savings would result.

1456 **Measurement of the Rate Coefficients for the Bimolecular and Termolecular Ion-Molecule Reactions of AR^{+}_{2} with Selected Atomic and Molecular Species;** NSF/RA-790582; University of Texas at Dallas, Center for Quantum Electronics; Collins CB, Lee FW; July 1979; 8 p; NSF Grant No. ENG 7816930

This work reports the measurement of second and third order ion-molecule reactions of diatomic argon ions with 10 reactants selected because of their widely varying values of polarizability and dipole moment. In this study Ar^{+}_{2} destruction frequencies have been experimentally determined from measurements of optical absorption at 280 and 290 nm in high pressure afterglows of mixed gases excited by intense electron beam discharges. Data have been obtained as functions of argon pressure over the range from 1000 to 2500 Torr and as functions of the partial pressure of reactant from 14 to 100 mTorr. From these data, pressure-dependent rate coefficients have been extracted and subsequently resolved into contributions from second order bimolecular and third order termolecular components. The bimolecular components have been found to agree with tabulated values appearing in the literature. The sensitivity of the method has been sufficient to detect termolecular components as small as 2×10^{-30} $cm^{6} sec^{-1}$. The data indicate that the reaction probabilities are generally high. The sizes of these termolecular rates suggest their general importance in charge transfer reactions in plasmas at atmospheric pressures.

Note: Published in Journal of Chemical Physics, Volume 71, Number 1, July 1979, pp. 184-191.

1457 **Microprocessor Based Prosthetic Control, Third Quarterly Progress Report (October 1, 1979—December 31, 1979);** NSF/RA-790522; Scientific Systems, Inc.; Gustafson DE, Jarisch W; 1979; 27 p; NSF Grant No. PFR 7821670; NTIS Order No. PB81-111627/NKS

Problems concerning data collection and data modeling of properties of the surface electromyogram (EMG) signal were studied. Data collection concentrated on selection and design of an appropriate electrode/preamplifier system. Concern about linearity and noise led to a theoretical investigation of several alternative possibilities which indicate that, contrary to common practice, a bipolar transistor input arrangement would outperform all current FET-based designs for pre-amplifiers. In the area of physiological modeling, a framework is presented to investigate the EMG signal. Several aspects about stochastic properties of the signals as they are observed are easily related to theoretical considerations. These are general enough to cover a wide range of possible situations and suggest certain mixed parametric/non-parametric approaches for purposes of modeling. Progress in solving a number of subproblems is summarized.

1458 **Near-Equivalence of Network Flow Algorithms, Technical Report;** NSF/RA-790580; Stanford University, Department of Operations Research; Zadeh N; December 1979; 54 p; NSF Grant No. ENG 7612266; NTIS Order No. ADA088032/8/NKS

Network problems arising in practice typically have non-negative arc costs. such problems show that the following algorithms perform, modulo ties, the same sequence of flow augmentations. (1) Simplex (with the standard pivot rule and Big-M start; (2) Out-of-Kilter (Primal-Dual); (3) Dual Simplex (with the standard pivot rule); and (4) Lemke's Complementary Pivot Algorithm. All methods compute a shortest path tree by mimicking the Dijkstra algorithm and then send flow along a sequence of minimum cost paths. Differences in implementation are discussed. It becomes clear that Dantzig's simplex method with the best empirical pivot rule (not the standard rule) will outperform other methods (variations of Simplex with the standard rule). A simple reason is given why Dual Simplex (best empirical) cannot do as well as Simplex (best empirical).

1459 **Needs and Design Concepts for Voice-Output Communication Aids, First Semi-Annual Progress Report (October 1, 1979—March 31, 1980);** NSF/RA-800178; Telesensory Systems, Inc. Brugler JS, 51 p; NSF Grant No. PFR 7917629; NTIS Order No. PB81-111668/NKS

Investigated is the current state of the art of systems and devices for people experiencing severe communication problems. The report focuses on the need for systems incorporating electronic voice output. The human factors affecting the design of such systems within the communication aids fields are examined. The report describes start-up activities, an evaluation of existing voice-output communication aids, consumer

requirements analysis, workshop organization, including plans for a national workshop at Berkeley, California, to present results of the initial phase of the project, analysis of alternative approaches, and problems and future activities. Copies of evaluation survey correspondence and forms, project announcements, and workshop agenda also are included.

1460 **New Algorithms for Assignment and Transportation Problems;** NSF/RA-790509; Massachusetts Institute of Technology, Laboratory for Information and Decision Systems; Bertsekas DP; September 1979; 40 p; NSF Grant No. ENG 7906332; NTIS Order No. PB80-218625/NKS

A new method for solving the classical assignment problem is proposed. In some ways the algorithm resembles the Hungarian method. The worst case computational complexity of one implementation of the algorithm for full dense, all integer, NxN problems is the same as the Hungarian method. However, the average complexity of the algorithm seems to be considerably better than the Hungarian method. In a large number of randomly generated problems the algorithm has consistently outperformed an efficiently coded version of the Hungarian method by a broad margin. On heuristic grounds, it appears that the new method owes its good performance principally to a phenomenon referred to as 'outpricing,' a property of the method whereby during the course of the algorithm the prices of some sinks are increased by large increments, much larger than in the Hungarian method. As a consequence, these sinks are temporarily or permanently outpriced by other sinks and are, in effect, driven out of the problem in the sense that they do not get labeled and scanned further for relatively long time periods. As a result, the algorithm requires fewer row operations since it deals with a problem of lower dimension.

1461 **On Estimating the Probability Distribution Functions in PERT-Type Networks Revision, Technical Report;** NSF/RA-800401; North Carolina State University; Dodin B; June 1980; 77 p; NSF Grant No. ENG 7813936; NTIS Order No. ADA088296/9/NKS

This study deals with the problem of approximating the probability distribution function of the project duration in probabilistic activity networks. It describes a procedure that has been developed, programmed, and tested using activity networks of real life projects as well as randomly generated ones. The procedure allows the activity duration to have any of the following distributions: Uniform, Triangular, Normal, Exponential, Gamma, Beta or any discrete distribution presented in a finite set of ordered pairs. The computational experience indicates that the resultant probability distribution function (pdf) is very close to the actual pdf; the latter is obtained through extensive Monte Carlo sampling. In fact, computational experience shows that the pdf obtained by Monte Carlo sampling converges to the approximate pdf as the sample size increases. The procedure is programmed in FORTRAN, and the CPU time for any moderate size project (i.e., G(N,A)< or = G(60,200)) is less than half a minute on AMDAHL V-7. (Author Abstract)

1462 **On the Distribution of Multidimensional Reflected Brownian Motion;** NSF/RA-800145; Systems Control, Inc.; Harrison JM, Reiman MI; February 1980; 45 p; NSF Grant No. ENG 7824568; NTIS Order No. PB80-211774/NKS

The multidimensional diffusion process Z, simply called reflected Brownian Motion, which arises in the heavy traffic theory for networks of queues is studied. Its state space is the K dimensional non-negative orthant, where K is a positive integer. On the interior of this state space, Z behaves like ordinary K-dimensional Brownian Motion with a given covariance matrix and drift vector. At each of the (K-1) dimensional hyperplanes that form the boundary of its state space, Z reflects instantaneously in a direction that is constant over that boundary hyperplane. The backward equation for the transition density function with boundary and initial conditions, the corresponding forward equation, and the equation for the steady-state distribution are all derived informally. Various calculations are presented relating to steady-state distribution, including a moment formula and the derivation of a condition involving the drifts and directions of reflection. The relevance of reflected Brownian Motion for approximate analysis of queueing networks is reviewed, and further references on the associated differential equations are given.

1463 **Sequential Conjugate Gradient-Restoration Algorithm for Optimal Control Problems with Non-Differential Constraints and General Boundary Conditions, Part 1;** NSF/RA-800147; Rice University; Wu AK, Miele A; 1980; NSF Grant No. ENG 7916667

The algorithm presented is of the conjugate gradient type, which is designed to solve two classes of optimal control problems. The approach taken is a sequence of two-phase cycles, composed of a conjugate gradient phase and a restoration phase. The conjugate gradient phase involves one iteration and is designed to decrease the value of the functional, while the constraints are satisfied to first order. The restoration phase involves one or more iterations. Each restorative iteration is designed to force constraints satisfaction to first order, while the norm squared of the variations of the control, the parameter, and the missing components of the initial state are minimized.
Note: Published in Optimal Control Applications and Methods, Volume 1, 1980, pp 69-88.

DIRECTORATE FOR ENGINEERING

Division of Electrical, Computer, and Systems Engineering

1464 **Sojourn Times in Markov Queueing Networks: Little's Formula Revisited, Interim Report;** NSF/RA-800398; University of Michigan at Ann Arbor, Computer Information and Control Engineering Program; Beutler FJ; June 1980; 37 p; NSF Grant No. ENG 7520223; NTIS Order No. ADA089658/9/NKS

It is commonly supposed that L = lambda W applies to 'almost any' queueing system, with lambda the mean customer entrance rate, L the asymptotic expectation of the number of customers in the system, and W the asymptotic sojourn time expectation. The formula is studied for irreducible positive recurrent Markov queueing systems whose state vector Z consists of entries representing queue lengths at the respective service stations; such a model permits blocking, finite capacities, jockeying, state-dependent or random routing, bulk and/or Erlang service, and variable arrival and service rates. To define waiting times under various queueing disciplines, Z is augmented by a customer location process to yield the new Markov process Y = (Z,U). It is shown that the standard regenerative process proof of Little's equality fails in the absence of further hypotheses; however, additional assumptions assure the validity of L = lambda W for a broad variety of queueing disciplines.

1465 **Sticky Brownian Motion as the Limit of Storage Processes;** NSF/RA-790507; Systems Control, Inc.; Harrison JM, Lemoine AJ; August 1979; 24 p; NSF Grant No. ENG 7824568; NTIS Order No. PB80-212897/NKS

The diffusion limits of modified storage processes are examined. Since sticky Brownian Motion has one more parameter than ordinary reflected Brownian Motion, it is a more flexible model of physical systems. The primary objective of this work is to exhibit a concrete setting in which this exotic process arises. It is shown that a modified storage process W can be obtained by applying first a reflection mapping and then a random change of time scale to a translated compound Poisson process X. The sticky Brownian Motion process W* is obtained by applying the same transformation (reflection plus change of time scale) to an unrestricted Brownian Motion process X*. The modified storage process W is constructed. The sticky Brownian Motion W* is constructed similarly and a review is made of its analytical properties. In particular, the stationary distribution of W* is calculated. The limit theorem is proven, using the theory of weak convergence in function spaces.

1466 **Tables of Queue Size and Waiting Time Distributions for M/M/c, M/D/c Queueing Systems, Technical Report;** NSF/RA-800396; Stanford University, Department of Operations Research; Avis DM, Edison LA, Fossett LD, et al; March 1980; 95 p; NSF Grant No. ENG 7514847; NTIS Order No. ADA089540/9/NKS

This report provides a relatively comprehensive set of tables describing the steady-state behavior of M/M/c, M/D/c, and D/M/c queueing systems. The results given are the probability distribution of the number of customers in the system (including those being served) and of the waiting time of individual customers in the queue (excluding service time), as well as the expected number of customers in the queue (excluding those being served). The cases considered are c = 1,2,..., 10 and c = 15 for all three classes of queueing systems, plus c = 12 for M/Dc and c = 20,25 for M/M/c. For each case, the results are tabulated for 16 values of the traffic intensity ranging from 0.10 to 0.99. Also included for comparative purposes are the corresponding results for two related cases, D/E2/2 and M/E2/2. These data represent one portion of the output from a large-scale project of theoretical research, algorithmic development, and computational effort to generate the obtainable numerical results for various classes of GI/G/c systems. (Author Abstract)

Note: This report is available from NTIS in microfiche form only.

1467 **Tables of Queue Size Distributing for Queueing Systems with Erlang Interarrival Times, Technical Report;** NSF/RA-800397; Stanford University, Department of Operations Research; Avis, DM, Edison LA, Fossett LD, et al; March 1980; 112 p; NSF Grant No. ENG 7514847; NTIS Order No. ADA089541/7/NKS

This report provides a relatively comprehensive set of tables describing the steady-state behavior of certain basic types of queueing systems having an Erlang distribution for the interarrival times. (Author Abstract)

1468 **Tight Bounds on the Response of Multivariable Systems With Component Uncertainty;** NSF/RA-790577; University of Southern California; Safonov MG; August 1979; 10 p; NSF Grant No. ENG 7805628; NTIS Order No. ADA086580/8/NKS

For Multi-Input-Multi-Output (MIMO) feedback systems having internal components that are subject to parameter variations, nonlinearity, or unmodeled dynamics within given 'conic sector' bounds, tight bounds (which also turn out to take the form of 'conic sector' bounds) are derived for the input-output relation of the closed-loop system in the case of linear-time invariant systems, the 'conic sector' bounds are interpretable in terms of the maximal singular values of certain frequency-response matrices. (Author Abstract)

DIRECTORATE FOR ENGINEERING

Division of Electrical, Computer, and Systems Engineering

1469 **What is the Worst Case Behavior of the Simplex Algorithm, Technical Report;** NSF/RA-800395; Stanford University, Department of Operations Research; Zadeh N; May 1980; 30 p; NSF Grant No. ENG 7612266; NTIS Order No. ADA089486/5/NKS

The examples published by Klee and Minty in 1972 do not preclude the existence of a pivot rule which will make the simplex method, at worst, polynomial. In fact, the continuing success of Dantzig's method suggests that such a rule does exist. A study of known examples shows that (a) those which use 'selective' pivot rules require exponentially large coefficients and (b) none of the examples' pivot rules are typically used in practice, either because of computational requirements or due to a lack of even-handed movement through the column set. In all 'bad' problems, certain improving columns are entered about 2 to the m-2 power times before other improving columns are entered once. This is done by making the unused columns 'appear' to yield small objective function improvement. The purpose of this paper is to explain the Klee-Minty and Jeroslow constructions, show how they can be modified to be pathological with small integral coefficients, and then suggest a 'least entered' pivot rule which forces an improving column to be entered before any other column is entered for the second time. This rule seems immune to the 'deformed product construction' which is the essence of all known exponential counterexamples. (Author Abstract)

DIRECTORATE FOR ENGINEERING

Division of Mechanical Engineering and Applied Mechanics

1470 **Coherent Structures in the Similarity Region of a Two-Dimensional Turbulent Jet: A Vortex Street;** NSF/RA-800400; Purdue University, Ray W. Herrick Laboratories; Oler J W, Goldschmidt VW; March 1980; 198 p; NSF Grant No. ENG 7420780; GK 19317; NTIS Order No. ADA088750/5/NKS

The characteristics of the coherent structures of a plane jet were evaluated experimentally and with a kinematic numerical representation. Distributions of intermittency and interface crossing frequency were measured for 10 less than or equal to x/D less than or equal to 60. These properties, including the maximum interface crossing frequency, were found to scale as self-preserving flow variables. Spatially coherent patterns within the turbulent velocity field were evaluated utilizing two point velocity correlation measurements. From these, it was found that the instantaneous velocity fluctuation distributions are antisymmetric with respect to the centerline and coherent over the entire width of the flow field. In addition, the patterns are periodic in the streamwise direction. The two-dimensionality of the large structures was evaluated through the comparison of longitudinal and vertical integral length scales derived from correlations in the fully turbulent zone and the intermittent region.

1471 **Data Analysis Methods for Short Rod and Short Bar Fracture Toughness Tests of Metallic Materials;** NSF/RA-800078; TerraTek; Barker L M; March 1980; 39 p; NSF Grant No. DAR 7820993; NTIS Order No. PB80-205685/NKS

The behavior of short rod and short bar metallic specimens when measured for plane-strain fracture toughness is described. Such measurements are of increasing interest due to a simplicity of specimen design, small specimen size, automatic creation of a natural precrack without fatigue, and the accuracy and reproducibility of test results. The report describes four basic behavior types and the procedures used for data analysis. Most materials have a relatively smooth crack during testing, but some, including many steels, exhibit a jump behavior which requires a different procedure. Specimen geometry, test procedures, and data analysis methods combine to provide good measurements of the plane-strain fracture toughness, even in the presence of macroscopic stresses and limited plasticity during the test. Criteria for judging the validity of test procedures are presented.

1472 **Magnetic Sheet Steel Lamination Detection, Phase 1, Final Report;** NSF/RA-800182; Advanced Mechanical Technology, Inc.; Carignan FJ, Syniuta WD; August 1980; 46 p; NSF Grant No. DAR 7917155; NTIS Order No. PB81-104929/NKS

The feasibility of a non-destructive magnetic inspection technique for detecting defective sheet steel is assessed. A major problem in the deep drawing and stamping industry is the failure of sheet steel due to "laminations" which occur when the steel is formed into various shapes or processed further. A continuous nondestructive testing method was developed based upon differences in magnetic properties of acceptible and defective steels. The technique assumes an increase in the magnetic hardness of the defect compared to the base material. Experimental results obtained with the artificial flaw demonstrate that it is possible to sense magnetic differences in sheet steel if the differences are large enough. However, as the differences in magnetic hardness diminish, or where thin surface defects or internal laminations occur, detection becomes increasingly difficult. Moreover, it has not been established that all sheet steel defects are magnetically harder than unflawed material. It was concluded that the technique, which can detect only some flaws and is incapable of detecting many important defects, would be only marginally useful.

1473 **Selective Thermal Radiators, Final Report, Phase 1;** NSF/RA-800128; Eikonix Corporation; Hauer CR; May 1980; 38 p; NSF Grant No. DAR 7917224; NTIS Order No. PB80-225212/NKS

The objective of this work was to determine if a "prepared surface" could serve to tailor the radiant output of a surface within the thermodynamic limits of blackbody radiation. Experiments used ion implantation to modify the radiation and evaporation surface properties of tungsten filaments operating at about 2800 degrees K. Tungsten filaments ion-implanted with carbon at low energy showed an ability to dissipate more energy than unimplanted tungsten filaments when operated in parallel prior to filament failure. Infrared reflectance measurements of a blackbody source indicated anomolous behavior, in that the reflectance and emittance of the surface appeared to be a strong function of the wavelength in the vicinity of the period. There appeared to be a concomitant shift toward longer wavelengths in the peak of the reflected blackbody radiance spectrum when a periodically structured reflector was used. These results were not conclusive of the postulates that either ultrathin filament surface coatings could modify evaporation rate or emissivity, or that a periodically structured surface could suppress long wavelength emittance.

1474 **Torque Limiting Sockets for Impact Wrench, Final Report;** NSF/RA-800034; Bethesda Corporation; Raff S; 1979; 32 p; NSF Grant No. DAR 7917093; NTIS Order No. PB81-102766/NKS

Described is a torque limiting socket for an impact wrench which achieves torsional resilience through the use of elastomers. At present the major restriction preventing the impact wrench from much wider usage is the limited range of bolt sizes which can be used with it without the use of a very com-

plex mechanism to control torque. To solve this problem, a rotationally resilient member between the impact wrench and the driving socket could serve as a torque limiting device and controller. Recent developments in elastomers render them promising for this application. This project demonstrated the concept and established the design principles. The urethane rubber elastomer used proved quite durable. No failures were observed after initial bonding problems were solved. Severe problems in reproducibility are not understood, but they appear to be due to measurement error rather than to inherent properties of the device.

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*Principal Investigator for this NSF supported research project—no individual report author listed.

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*Principal Investigator for this NSF supported research project—no individual report author listed.

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Division of Industrial Science and Technological Innovation

1475 **Advanced Technology Applications in Garment Processing, Final Summary Technical Report;** NSF/RA-790294; Georgia Institute of Technology; Bangert L H, Lundberg J L, Muzzy J D, et al; August 1979; 143 p; NSF Grant No. APR 7402326; NTIS Order No. PB80-173828/NKS

Several specific technologies have been explored which may form part of the knowledge base necessary for the successful conversion of polymer chips and/or staple fiber directly into garments without spinning, weaving or knitting, cutting, and sewing. It is shown that polybutene-1 and polypropylene are soluble in n-butane and carbon dioxide, and nylon-6 dissolves in carbon dioxide. Lightweight polypropylene, polybutylene, and PBT fibrous webs formed by melt foam fibrillation. Polypropylene foam fibrillated webs were converted into medium-strength yarn. Natural and staple fiber was oriented in low velocity air streams using counterflow jets and deposited on a screen without loss of orientation.

1476 **Coatings Research Institute, Final Report on Planning Grant (July 1, 1979—June 30, 1980);** NSF/RA-800116; Kent State University, Department of Chemistry; Myers RR; July 1980; 123 p; NSF Grant No. ISP 7912270; NTIS Order No. PB80-221906/NKS

This report describes a study to ascertain the best configuration of a research institute for the coatings industry. Six possible formats were considered from which a hybrid organization, based at a university but operated with industry control of both personnel and programs, was recommended. The institute would conduct long-term relevant basic research on problems faced by major segments of the industry. This research would be part of a larger effort embracing applied problems, compliance problems, critical summaries, and education. Successful operation of the institute would require a full-time director selected and paid by the industry; an annual budget of $300,000-$500,000; three-year commitments from large and medium-sized companies; formal arrangements with a university; and government assistance for a period of three to five years. Achieving these goals would depend on the support of both the professional society and the trade association which serve the coatings industry.

1477 **Programmable Assemble Research Technology Transfer to Industry, Phase 2, Second Quarterly Report;** NSF/RA-790393; Westinghouse R & D Center; Abraham RG, Stewart RJS, Csakvary T, et al; June 1979; 60 p; NSF Grant No. ISP 7818773; NTIS Order No. PB80-164809/NKS

The preliminary layout design of the end bell subassembly portion of the pilot experimental adaptable-programmable-assembly system (APAS) has been completed. Approximately one half of the final station layout designs for end bell subassembly also have been completed. Detailed design of the software for the supervisory computer and vision system have been completed. Experiments with all small motor parts led to a final design concept for a programmable belt feeder which will be tested soon. Benchtop tests using a special fixture and tool reduced the risk of automatic wick insertion into the end bell bearing bore. Experimentation with reflected lighting instead of backlighting commenced, using end bells and dust caps, with positive results thus far.

1478 **Programmable Assembly Research Technology Transfer to Industry, Phase 2, Fourth Quarterly Report;** NSF/RA-800077; Westinghouse R & D Center; Cowart N, Csakvary T, Meyerhoff A, et al; March 1980; 68 p; NSF Grant No. ISP 7818773; NTIS Order No. PB80-224025/NKS

Tasks accomplished during this phase include the completion of three-dimensional layout drawings of the pilot adaptable-programmable assembly system (APAS) for end bell subassembly and motor final assembly. Final layout design for the end bell system was completed and was 40 percent complete for the motor final assembly system. Seven of the nine grippers were detailed and four fabricated. The wick insertion tool was modified to improve its performance. The vision data base software was redesigned for the multi-tasking executive operating system, RSX-11M. Considerable progress was made in the design of the communications monitoring software, and programming work was started. Recognition and orientation determination of end bells viewed with reflected light on a flat black background were successfully demonstrated. The lighting required was even illumination from the existing room illumination. Initial experiments were conducted to perform inspection of the underneath portion of the end bell with reflected light; indications were that reflected light will be sufficient for this task. A new technique for training inspection tasks was developed in which features of parts are inspected in fixed positions in the field of view. The PUMA robot was delivered and installed, and work was begun on interfacing the PUMA to the vision system. A paper entitled "Mathematics of a Five-Axis PUMA Industrial Robot" was prepared and is included in this report.

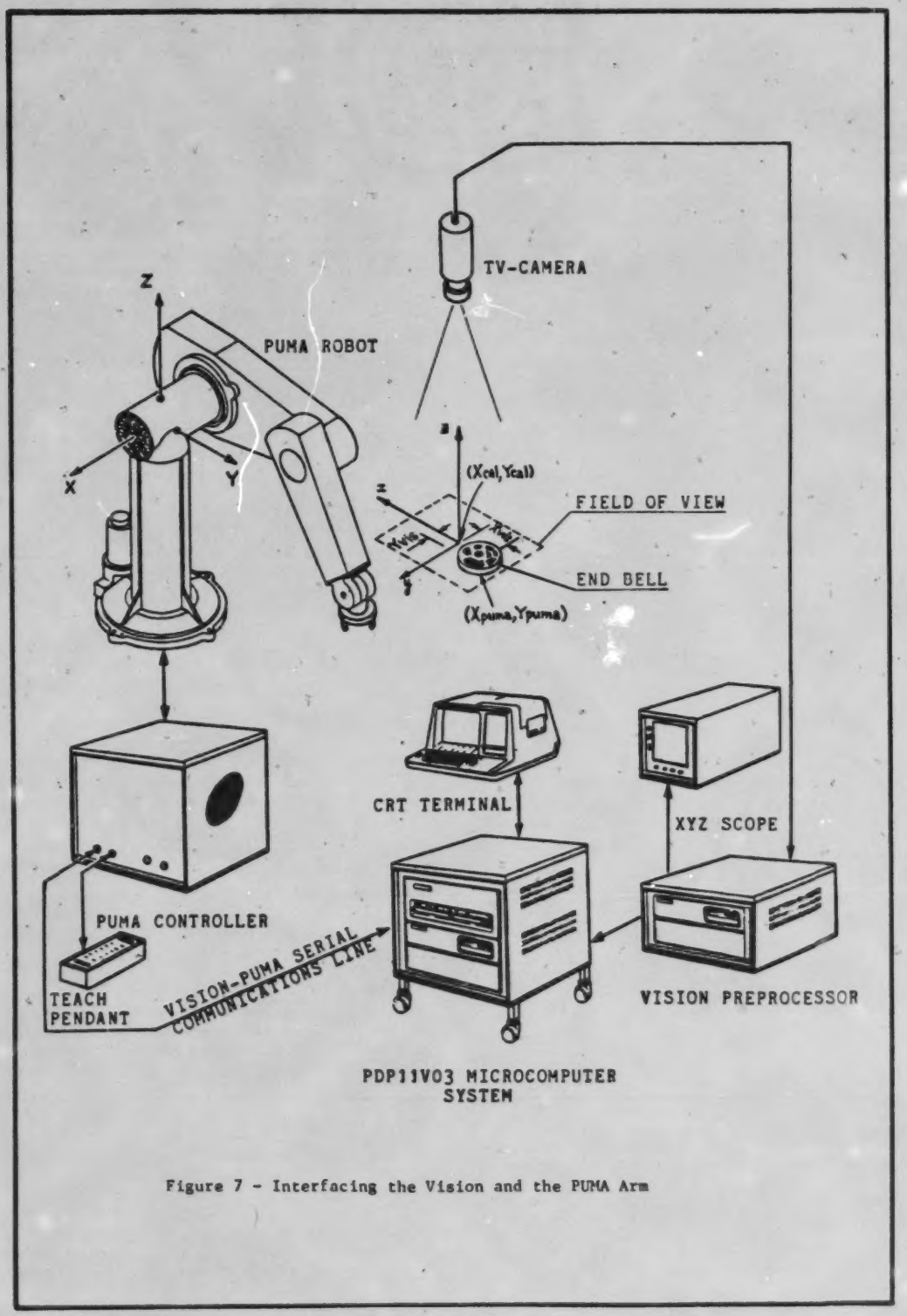

Figure 7 - Interfacing the Vision and the PUMA Arm

See Entry 1478

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Division of Intergovernmental and Public Service Science and Technology

1479 **Abstracts of Publications 1967-1978, Intergovernmental Program;** NSF/RA-800080; National Science Foundation; Rogers L E, Editor; 1980; 172 p; NTIS Order No. PB80-217433/NKS

This collection of over 500 abstracts summarizes publications resulting from grant awards of the Intergovernmental Program during the years 1967 to 1978. Citations are arranged by broad subject areas and include the following information: abstract, title, author, performing organization, awardee, publication date, pagination, and NTIS order number. Those in the Program Area Reports section are grouped by the impact area: local government, state government--executive branch; state government--legislative branch, and scientific and technical resources. The local and state government areas are further subdivided into program development and assessment, individual jurisdictions, multiple jurisdictions, and national networks. The scientific and technical resources area is subdivided into higher education, Federal laboratories and centers, public-private cooperation, and utilization of science and technology. Citations in the Technical Case Studies section are arranged under the following subjects: community and economic development; energy; health and human resources; management, finance and personnel; natural resources and environment; public safety; public works; and transportation. Multiple indexes have been provided to facilitate reference use.

1480 **Colorado General Assembly Science and Technology Resource Needs Assessment Study (March 1978 to August 1979);** NSF/RA-790346; Colorado, State of, Legislative Research Council; Mann F; August 1979; 247 p; NSF Grant No. ISP 7802517; NTIS Order No. PB80-189491/NKS

This study evaluates the Colorado General Assembly's needs for scientific and technological (S & T) resources. Potentially useful ways to improve the Legislature's capacities to use S & T resources in its policy formulation, decisionmaking, and legislative processes are identified. A needs assessment survey found that between 14 and 27 percent of the bills introduced in a recent legislative session might require S & T expertise, knowledge, or research. Efforts to ascertain how needs for S & T inputs were made by committee members and Legislative Research Council (LRC) members ex post facto were unsuccessful. However, useful information was obtained on how inputs from S & T were perceived as technical or vested-interest inputs. Also identified were the points where such information might be introduced into the bill-formulating procedure in Colorado. Other states' institutional mechanisms for increasing their use of S & T resources were studied. The Colorado legislative plan that emerged involves: (1) continuing to rely on the LRC for S & T information; (2) augmenting LRC's supportive capacity; (3) assigning a scientist to test the usefulness of additional S & T expertise within LRC; and (4) inviting Colorado's universities and schools to increase their commitment to provide S & T research.

1481 **Evaluation of Air Pollution Abatement Relaxation Strategies for Tennessee During Periods of Pending or Actual Emergencies, Tennessee State Science, Engineering, and Technology Project, Final Report;** NSF/RA-800098; Tennessee, State of; Clinard L, Backhus D, Koehler W; 1980; 185 p; NSF Grant No. ISP 7811784; NTIS Order No. PB81-114605/NKS

This report addresses problems associated with the relaxation of air pollution abatement strategies, during periods of pending or actual energy emergencies, for coal-fired plants in Tennessee. Several general and specific constraints which policymakers face in implementing the relaxation of air pollution standards are reviewed: the emission standards required for compliance with the Tennessee State Implementation Plan; a pending consent decree, issued by a Federal district court, relative to pollution abatement equipment required for compliance at several Tennessee Valley Authority steam plants; the regional character of the Tennessee Valley Authority, coupled with the fact that it is a Federal agency; and the need for legal consistency with existing Tennessee and Federal statutes and for considerations of courtesy for overlapping state agencies. Specific strategies and procedures are offered for securing variances from the abatement requirements of the Clean Air Act legislation and the Tennessee State Implementation Plan. Recommendations of the study include the establishment of an Advisory Group, administered by the Tennessee Energy Authority as the lead state agency. Appropriate actions to be taken by the Advisory Group are to be based on average days of recoverable coal supply at plants affected during such energy emergencies.

1482 **A Focus on Florida's Science, Engineering and Technology Legislative Information Needs: A Report and Recommendations for the Florida House of Representatives (SSET);** NSF/RA-800091; Florida Legislature; Albritton G, Zipser L; February 1980; 130 p; NSF Grant No. ISP 7815356; NTIS Order No. PB81-103236/NKS

The project described is designed to: (1) identify sources of scientific, engineering, and technology (SET) information available to the Florida Legislature; (2) determine the legislature's need for SET information in formulating state law and policy; and (3) recommend alternative methods whereby SET information of superior quality can be made available to the legislature. A survey eliciting reactions of Florida legislators indicates that they are cognizant of and concerned with the increasing scientific and technological implications inherent in formulating state policy and law. However, efforts to identify and utilize SET resources

have been fragmented and unsystematic. To optimize the legislature's ability to deal in a knowledgeable way with SET-related issues, five programs are recommended. These involve establishing a computerized resource and information system, an SET intern/extern program, a faculty service/ consultant staff, an SET advisory committee, and the position of legislative staff scientist.

1483 **Innovations: Simplifying Federal Grant-in-Aid in Arizona and Kentucky;** NSF/RA-800092; Council of State Governments; Seymour S, Howard D; January 1980; 18 p; NSF Grant No. ISR 7521176; NTIS Order No. PB80-212533/NKS

The Joint Funding Simplification Act was enacted by Congress to simplify the process whereby grantees apply for, receive, and administer funds from several Federal agencies. Arizona's joint funding program is in its fifth year. The FY 1980 grant requests amount to $3,683,482 from the Federal Government to be matched with $974,945 in state and local funds. There are eleven state and sub-state governmental entities and eight Federal agencies participating in the joint funding program. In Kentucky, the total amount requested under joint funding for FY 1980 from the Federal Government is $3,672,555. The state's contribution is $2,036,650, the bulk of which is the required matching funds. Kentucky, in contrast to Arizona, provides most of the local government match. Local governments are required to put up only $329,401 for matches for a total of $6,038,607. The types of participants in the joint funding program are reviewed for each of these two states. The application, funding, and implementation process for each is reviewed. Joint funding advantages are discussed, as well as the transferability of the experience of these two states for other states.

1484 **Institutional Change and Legislative Performance: A Study of Change in Two State Legislatures by the State Legislative Leaders Foundation;** NSF/RA-790100; State Legislative Leaders Foundation; Davis C O; May 1979; 204 p; NSF Grant No. ISP 7714688; NTIS Order No. PB80-175920/NKS

The first stage of a new State Legislative Leaders Foundation's (SLLF) understanding of legislative change and its impact upon performance is reported. It represents a comprehensive, detailed examination of the effects of legislative change in the states of Iowa and Wisconsin over 12 years. The project seeks to discern if there were the expected improvements and to assess the impact of change upon the effectiveness of legislatures and policies enacted by their legislators. It combines both theoretical and applied interests, but focuses on the latter. A macrolevel theory is tested regarding the effects of change in a legislature's organization on the subsequent performance of the legislature in its processing effectiveness of policy decisions and the nature of policy decisions made by the legislature. The effects of policy decisions and the outcomes of these policies also are investigated. A legislative processing model, research strategy, data collection, change in the legislatures' 1967-1978 bivariate and multivariate analyses, policy area case studies, and utilization of the completed part of the project are included in the report.

1485 **Joint Ad Hoc Science and Technology Planning Committee, Report of the Washington State Legislature (SSET);** NSF/RA-800075; Washington State Legislature/ Joint Ad Hoc Committee on Science Technology; Bricker J; February 1980; 86 p; NSF Grant No. ISP 7812732; NTIS Order No. PB80-205057/NKS

In assessing the options for providing S & T information to the Legislature, a review of current literature was conducted, and other state legislatures with similarities to Washington's were surveyed. Two states, Arizona and Minnesota, were selected for examination, due to similarities in staffing patterns and other relevant legislative functions and structure. A report was prepared on these examinations and is included in this study. Based on these and other considerations, both committee staff and the Technical Advisory Committee recommended an S & T information system structure with certain parallels to the Arizona and Minnesota patterns. The recommended S & T Office could serve several functions, including responding to legislative S & T inquiries, and organizing workshops on specific issues. The Joint Committee determined that S & T information should be made available to support the legislative process in various ways: quick informational responses, position papers, expert testimony, and concerted workshops on issues of major S & T impact. Both as a system test and as a means of providing needed S & T information to the Legislature, the Joint Committee sponsored an appropriate S & T workshop on issues confronting the Legislature. The issue of nuclear waste management disposal was examined in a demonstration legislative workshop. Results of the workshop are presented. Finally, recommendations for the final system design are offered.

1486 **Massachusetts Growth Policy Communications Project, Final Report;** NSF/RA-790349; Massachusetts, Commonwealth of, Office of State Planning; March 1979; 7 p; NSF Grant No. ISP 7814305; NTIS Order No. PB80-164387/NKS

This project was designed to assist in the formulation of a statewide growth policy for Massachusetts. As implemented, the program involved fulfilling functions outlined for the Growth Policy Act and improving the communication of findings and recommendations among participants throughout the process. The state's growth policy was

based on an extensive network of local Growth Policy Committees which resulted in a high level of citizen participation. The process included preparation of Local Growth Policy Statements in response to a questionnaire prepared by the Office of State Planning. These were widely circulated to enable communities to learn from each other and to increase public awareness of the project. Regional planning agencies developed reports that the Office of State Planning incorporated in a statewide report outlining local, regional, and state perspectives on growth. In addition, it organized recommendations for action under the following areas that emerged in the growth policy process: centers, neighborhoods, buildings, jobs, farms, wetlands/scenic rivers/the coastline, water, growth management, regions, and property tax. A series of regional forums was conducted for elected and municipal officials on local land use, planning, management, and policy development.

1487 **New York State Science, Engineering and Technology Program, Phase I, Final Report (SSET);** NSF/RA-800033; New York State Energy Office; Larocca J L, Principal Investigator; February 1980; 78 p; NSF Grant No. ISP 7727039; NTIS Order No. PB80-208648/NKS

This report discusses the results of a planning study conducted by the State Planning Bureau of South Dakota under the State Science, Engineering, and Technology (SSET) Program. Over the past two years, changes have taken place in both the state administration and in planning for the future of state higher educational institutions. Described are changes made in the annual policy development and review process. These include a closer working relationship between the governor and majority party in both houses of the legislature, a commitment by the administration and legislative leadership to lessen the overall role of state government relative to local and private initiative, and changes in the administrative structure of the State government. Governmental and academic relationships are addressed in terms of reactive and anticipatory roles for academic research. The work of the Academic Resources Council (ARC), requests for proposals, monitoring of research grants, a scientific research improvement program, and continuing needs for an SSET program are discussed. The appendices include a policy issue analysis, minutes of ARC meetings, and listings of cabinet subgroups.

1488 **Networking, Legitech Experiments and the Development of Politechs;** NSF/RA-800096; Participation Systems, Inc.; Stevens CH; June 1980; 58 p; NSF Grant Nos. DSI 7727940, DSI 7717838; NTIS Order No. PB80-205669/NKS

Politechs is a communication system which supports political decisionmaking through the exchange of technical information needed to clarify policy options. Each participant potentially is an inquirer/selector/consumer and a responder/editor/producer. Information exchange within this system takes various forms. Electronically, inquiries and responses are exchanged through computer terminals connected by phone to Politechs. The Legitech exchange, involving legislatures and resource organizations, produced the more general Publitech Exchange which in turn spawned other political exchanges such as Localtech, which focuses on policy at the local level. The Networkbook contains inquiry briefs on energy, health, etc., and offers process options and case examples to help users learn various methods for exchanging technical information. It also includes a resource directory of agencies and technical organizations. Netnotes is a newsletter insert and order form for updating The Networkbook. The Networkbook assesses a full range of networking techniques including inquiry services, dialogue programs, in-depth research, networking arrangements, and support systems. This report also evaluates the Politechs-on-Electronic Information Exchange System (EIES). Additionally, a discussion of the Northeast Networkshop conference on the Legitech experiment on EIES is presented.

1489 **Review of Innovative State Criminal Justice Programs (Innovations);** NSF/RA-800093; Council of State Governments; Seymour S; March 1980; 18 p; NSF Grant No. ISR 7521176; NTIS Order No. PB81-115339/NKS

Several new, successful state programs designed to reduce crime are summarized. Each state corrections agency was surveyed by mail. The survey, as well as other data sources, forms the basis of this review. Topics discussed include prison industries, sentencing, improved apprehension of criminals, and different aspects of criminal justice. The purpose of the innovation, specific activities or operations, evaluation and performance, similar programs in other states, limitations to transfer, costs and sources of funding, and person for contact, is covered for the following programs: Minnesota Community Corrections Act; New Mexico State Crime Stoppers Program; California Uniform Determinate Sentencing Act; Oregon Pretrial Release Program; Minnesota Free Venture Program; Kentucky Pretrial Services Agency; Georgia Resititution and Diversion Centers; and North Carolina Pre-Release and Aftercare Program. Other innovative programs which are discussed more briefly include Utah's coordinated sentencing and parole release guidelines, Illinois' canine unit, Texas' apprenticeship and training program, Michigan's parole supervision project and mutual objectives probation, Florida's utilization of inmates on contract construction, and interagency work programs.

DIRECTORATE FOR SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS

Division of Intergovernmental and Public Service Science and Technology

1490 **State Science, Engineering and Technology Project (South Dakota), Final Report (SSET);** NSF/RA-790364; South Dakota, State of, Office of Executive Management; Merrick S. Principal Investigator; November 1979; 45 p; NSF Grant No. ISP 7803197; NTIS Order No. PB80-164049/NKS

This report discusses the results of a planning study conducted by the State Planning Bureau of South Dakota under the State Science, Engineering, and Technology (SSET) Program. Over the past two years, changes have taken place in both the state administration and in planning for the future of state higher educational institutions. Described are changes made in the annual policy development and review process. These include a closer working relationship between the governor and majority party in both houses of the legislature, a commitment by the administration and legislative leadership to lessen the overall role of state government relative to local and private initiative, and changes in the administrative structure of the State government. Governmental and academic relationships are addressed in terms of reactive and anticipatory roles for academic research. The work of the Academic Resources Council (ARC), requests for proposals, monitoring of research grants, a scientific research improvement program, and continuing needs for an SSET program are discussed. The appendices include a policy issue analysis, minutes of ARC meetings, and listings of cabinet subgroups.

1491 **State Telecommunications Activities (Innovations);** NSF/RA-800094; Council of State Governments; Seymour S; March 1980; 11 p; NSF Grant No. ISR 7521176; NTIS Order No. PB81-115347/NKS

Recent activities in the area of state government telecommunications, in response to the concerns and needs of the states, are highlighted in this report. The creation of the Virginia Public Telecommunications Council and the North Carolina Agency for Public Telecommunications is noted. While North Carolina and Virginia are presented as examples of how to solve the fragmentation and separation of telecommunications planning and operations in an organizational manner, the Kentucky Emergency Warning System serves as an example of how various systems may be aggregated technologically to reduce separation and fragmentation and to save money. Recent Federal activities relating to telecommunications are described. The results of a survey covering efforts to improve citizen access to state government are summarized.

1492 **UTS Briefs, 1-195 (Includes Index);** NSF/RA-800287/1-195; Public Technology, Inc.; R. Phillips, Principal Investigator; July 1980; NSF Grant No. ISP 7726003; NTIS Order No. PB81-158487/NKS

This directory or technical briefs is a compilation of short reports on technology at work in the cities and counties of the Urban Technology System (UTS). Technological developments throughout the latter half of the 1970s are summarized and represent a broad cross section of the United States. Each brief consists of statements of the problem, solution, results, and other considerations, as well as names of persons to contact. Subject areas include the following: community and economic development; criminal justice; energy; environmental services; fire safety and disaster preparedness; health; human services; management, finance, and personnel; public works and public utilities; and transportation.

Note: An index to these briefs is included in this report as Appendix A.

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Division of International Programs

1493 **International Directory of Current Biosaline Research Projects;** NSF/INT-800001; Smithsonian Science Information Exchange; July 1980; 512 p; NSF Grant No. INT 7818652; NTIS Order No. PB81-107401/NKS

Partial contents: Terrestrial saline biosystems (physiology and genetics of halophytes, environmental contamination, product management, product marketing and utilization, animals associated with saline environments); aquatic saline biosystems (physiology and genetics of aquatic biota, ecology and environmental studies, environmental contamination, product harvesting and utilization, mariculture).

1494 **Microbial Enzyme Reactions: Proceedings of the Fifth Conference of Project IV, Microbial Enzyme Reactions of the US/USSR Joint Working Group on the Production of Substances by Microbiological Means (Jurmala [Riga] Latvia, USSR, September 30—October 5, 1979);** NSF/RA-800104; American Society for Microbiology; Weetall HH, Bungay HR, Editors; April 1980; 746 p; NSF Grant No. INT 7719256; NTIS Order No. PB80-223803/NKS

Seventeen Soviet and fourteen U.S. papers review progress in the area of microbial enzyme reactions. Presentations cover broad areas including enzyme production; cofactor immobilization, industrial, medical and analytical application of enzymes; and new concepts in biochemical fuel cells and other enzyme-related programs. Topics include the thermal stability of enzymes; amino acid synthesis of microbial cells; fluorometric and electrochemical analysis of enzyme reactions; immobilization of medical enzymes on polymeric matrices; improved hydrogen photosynthetic bacteria and green algae; sugar recovery and fermentation from wood hemicellulose; uses of immobilized lactase in the dairy industry; and biomass production and utilization research supported by the National Science Foundation.

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Division of Policy Research and Analysis

1495 **Assessment of National Use, Choice and Future Preference Toward the Automobile and Other Modes of Transportation, Analysis of Motor Vehicle Ownership and Travel Patterns, Final Report, Volume One, Part One: Technical Report;** NSF/PRA-7716108/1; Cambridge Systematics, Inc.; Westat, Inc.; Sherman L; June 1979; 360 p; NSF Grant No. PRA 7716108; NTIS Order No. PB80-204175/NKS

Present and expected future household preferences toward the automobile and other modes of transportation are evaluated in this volume. The factors that influence consumer choices as reflected by current automobile ownership and alternatives to ownership are identified as well as travel patterns of the automobile and other modes of transportation. The analyses are based on a National Transportation Survey of approximately 1,100 households administered as part of this study in June 1978. Despite concerns for transportation energy conservation following the 1973 Arab oil embargo, the analysis in this volume confirms that recent demographic trends have continued to increase U.S. households' reliance on the private automobile. The prevalence of multiple household workers has led to increased automobile ownership levels. Sixty percent of the nation's vehicle-owning households now own two or more motor venicles. The recent growth in rural population places an increasing number of U.S. households in areas where dependence on the private automobile is paramount. The proportion of high income households living at distances beyond eight miles from the city center is higher than the corresponding proportion for closer-in households. The survey confirms that transit availability and service generally declines with distance from the city center. In the long run, the greatest potential for reducing automotive fuel consumption lies in a shift towards fuel-efficient vehicles.

1496 **Assessment of National Use, Choice and Future Preference Toward the Automobile and Other Modes of Transportation, Analysis of Motor Vehicle Ownership and Household Travel Patterns, Volume One, Part Two: Technical Appendices;** NSF/PRA-7716108/2; Cambridge Systematics, Inc.; Westat, Inc.; Sherman L; June 1979; 105 p; NSF Grant No. PRA 7716108; NTIS Order No. PB80-204183/NKS

The National Transportation Survey was administered to 1,095 households between mid-May and the end of June 1978. A national sampling frame was employed to obtain a broad representation of travel behavior. The survey questionnaire is presented in Appendix A. It contained three major blocks of questions. The first section, administered to a household head, established a complete inventory of the household's motor vehicles, specifying make, model, vintage, and options, so that baseline distributions of ownership by vehicle type, size, and weight could be determined. The vehicles sold by households over the year prior to the survey were also inventoried to provide limited time series data on trends in vehicle type choices as a function of household composition. Characteristics of the current and intended uses of the household's motor vehicles were also established. Household constraints and other factors that influence motor vehicle ownership and travel decisions were also covered in this section. The remaining two sections dealt with household travel behavior. Appendix B provides a complete and detailed record of question-by-question specifications. Sample design, sampling errors, and income adjustments for the National Transportation Survey are the topics of the remaining technical appendices in this volume.

1497 **Assessment of National Use, Choice and Future Preference Toward the Automobile and Other Modes of Transportation, Volume Two: Consumer Sentiments Towards Fuel-Efficient Vehicles;** NSF/PRA-7716108/3; Cambridge Systematics, Inc.; Westat, Inc.; Sherman L; June 1979; 202 p; NSF Grant No. PRA 7716108; NTIS Order No. PB80-204191/NKS

Consumer perceptions of the adequacy of energy resources and their corresponding attitudes toward motor vehicle fuel efficiency and driving habits are analyzed in this volume. The data used in the analyses were gathered in a series of nationwide random household surveys conducted between 1973 and 1978. The questions addressed what consumers have done in response to energy shortages and the new vehicle fuel economy standards. A sizeable number of respondents indicated in late 1976 and early 1977 a lack of interest in the EPA ratings, since fuel economy did not concern them in the choice of their car. In early 1977 vehicle-owning respondents were questioned about the most important characteristics for which they would look in replacing their current vehicles. Fuel economy proved to be overwhelmingly the most frequent response, although the phrasing of the question did not specify what other attributes might have to be compromised to achieve improved gas mileage. How consumers would prefer to have manufacturers achieve improved fuel economy from three broad options is covered in this report. Light truck ownership and user characteristics are analyzed in an attempt to explain shifts in the types of owners over the past five to ten years. The frequency of use of light truck hauling capacity is investigated as well as the major purposes of light truck travel.

1498 **Assessment of National Use, Choice and Future Preference Toward the Automobile and Other Modes of Transportation, Volume Three: An Empirical Analysis of Household Choice Among Motor Vehicles, Final Report;** NSF/PRA-7716108/4; Cambridge Systematics, Inc.; Westat, Inc.; Sherman L; June 1979; 67 p; NSF Grant No. PRA 77161108; NTIS Order No. PB80-204209/NKS

The direct statements of consumer preference underlying their vehicle type choices which were analyzed in the previous volumes of this report were found to have two drawbacks: (1) the questions eliciting direct statements of consumer preferences generally did not require respondents to make explicit tradeoffs between vehicle attributes; (2) the responses represent stated preferences of past or future choices rather than revealed preferences manifested by actual choice behavior. This volume presents an econometric model explaining the make, model, and vintage composition of individual household motor vehicle holdings in order to develop revealed preference estimates of the relative importance of vehicle cost, performance, and size. The empirical analysis is based on a national random sample of households. Two models are estimated. One model explains vehicle choices in households holding a single vehicle. The remaining model explains the composition of holdings in two-vehicle households. Findings reveal the importance of seating capacity and, to a lesser extent, luggage space as determinants of vehicle utility; that several aspects of vehicle performance do not strongly influence utility; and that the influence of operating costs varies widely among different segments of the population and for some may even be positive.

1499 **Assessment of National Use, Choice and Future Preference Toward the Automobile and Other Modes of Transportation, Executive Summary, Final Report;** NSF/PRA-7716108/5; Cambridge Systematics, Inc.; Westat, Inc.; Sherman L; February 1980; 47 p; NSF Grant No. PRA 7716108; NTIS Order No. PB80-204217/NKS

This document summarizes a final report which presents both a comprehensive evaluation of current nationwide patterns of household motor vehicle ownership and travel behavior, and insights into expected future household travel responses to changes in the demographic, transportation and energy environments. The final report is organized into three separate volumes: Volume 1, Analysis of Motor Vehicle Ownership and Household Travel Patterns; Volume 2, Consumer Sentiments Toward Fuel-Efficient Vehicles; and Volume 3, An Empirical Analysis of Household Choice Among Motor Vehicles. The basis for the analyses presented in Volume 1 is the National Transportation Survey (NTS) administered to 1,095 households between mid-May and the end of June 1978. A national sampling frame was employed to obtain a broad representation of travel behavior. Volume 2 describes analyses based on selected surveys spanning the period 1973-1978. Data were gathered from surveys conducted by the Survey Research Center on consumer sentiments toward energy conservation. Volume 3 presents an econometric model explaining the make, model, and vintage composition of individual household motor vehicle holdings. A brief description of the contents of each of the three volumes is included in this summary.

Note: Entry numbers 1495 through 1499 are available from NTIS as a set, Order Number PB80-204167, $45.50.

1500 **Factors Relating to the Implementation and Diffusion of New Technologies: A Pilot Study;** NSF/PRA-7703286/1; Arthur D. Little, Inc.; Morton AS, Principal Investigator; June 1979; 125 p; NSF Grant No. ERS 7703286; NTIS Order No. PB298998/NKS

In order to develop an understanding of how government intervention affects the processes of implementation and diffusion of new technologies, case studies of 14 technologies were carried out: automobiles, broadcast radio, frozen foods, black and white TV, color TV, polio vaccine, supersonic transport, fluoridation of water supplies, computer-aided instruction, basic oxygen process for steel, numerical control in manufacturing, digital computers, lasers, and integrated circuits. The key factors, their motivations for implementing/adopting the technology (or not doing so), the interactions among the key factors, and how these affected implementation/adoption are examined. Tabular presentations of the case study data show the criteria employed by the factors. A model was tested relating diffusion and time since development of the prototype. Facilitators and an inhibitor to acceptance are identified, and governmental actions which could affect these are described. The findings are qualitative and judgmental rather than quantitative. The report concentrates on a retrospective look at existing technologies.

1501 **Factors Relating to the Implementation and Diffusion of New Technologies: A Pilot Study, Volume One of Appendices Containing Case Studies;** NSF/PRA-7703286/2; Arthur D. Little, Inc.; Morton AS, Principal Investigator; July 1979; 155 p; NSF Grant No. ERS 7703286; NTIS Order No. PB80-124712/NKS

Case studies contained in this volume cover the automobile, broadcast radio, frozen foods, black and white television, and color television. These topics are considered under the following areas: scope of discussion; socioeconomic, political, and technological environment; the pre-commercial period; the "food chain"; the key actors; the commercial stage; comparative advantages; advertising, marketing, and public relations; resources; manufacturers; detailed technology; government; and consumers.

1502 **Factors Relating to the Implementation and Diffusion of New Technologies: A Pilot Study, Volume Two of Appendices Containing Case Studies;** NSF/PRA-7703286/3; Arthur D. Little, Inc.; Morton AS, Principal Investigator; July 1979; 178 p; NSF Grant No. ERS 7703286; NTIS Order No. PB80-124720/NKS

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Case studies contained in this volume include polio vaccine, supersonic transport, fluoridation of water suplies, computer-aided instruction, the basic oxygen process, numerical control of manufacturing, the digital computer, the laser, and the integrated circuit. These topics are considered under the following areas: scope of discussion; socioeconomic, political, and technological environment; the pre-commercial period; the "food chain"; the key actors; the commercial stage; comparative advantages; advertising, marketing, and public relations; resources; manufacturers; detailed technology; government; and consumers.

1503 **International Technological Competitiveness: Television Receivers and Semiconductors, Phase I;** NSF/PRA-7820301; Charles River Associates, Inc.; Wilson RW, Principal Investigator; July 1979; 141 p; NSF Grant No. PRA 7820301; NTIS Order No. PB81-150187/NKS

This report examines the competitive performance of U.S. firms in the international television receiver and semiconductor industries resulting from interaction between strategies they adopt and strategies of foreign firms. Strategies of U.S. firms depend on technological competitiveness, costs, competitive policies of domestic and foreign firms, and policies of both U.S. and foreign governments. The study is based on concepts of corporate strategy and strategic groups within an industry. An international comparison of technological developments in color television receivers is presented, including information on performance in the U.S. market and on development and worldwide performance of the Japanese color television receiver industry. Japanese and U.S. strategies are examined in the areas of costs, technology, government policies, market protection, private labels, and brand names. The report reviews technological developments in the semiconductor industry since 1960 and the sales position of U.S., Japanese, and European semiconductor firms. Strategies of the television receiver industry and the semiconductor industry are compared and the link among technology, strategies, and international competitive performance is analyzed. Finally, the report examines the role of government policy in influencing innovation, diffusion, and competitive performance in the industry.

1504 **Overseas R & D Activities of TNCs and S & T Policies of LDCs;** NSF/PRA-7721851/2; Fund for Multinational Management Education; Behrman JN, Fischer WA; 1979; 25 p; NSF Grant No. PRA 7721851; NTIS Order No. PB81-149031/NKS

A series of case studies concerning research and development (R & D) activities of five transnational corporations (TNCs) was initiated in 1977. The studies focused on a single product line from each company. Activities were surveyed in the United States and abroad. Instead of updating these studies, it was decided to test whether the results could be generalized. In a new phase involving 58 international companies operating in the United States, Europe, and Japan, the limits of inquiry were broadened. A better understanding of the relationship of science and technology (S & T) policies of developing countries to the R & D of international companies was sought. Nine less developed countries (LDCs) were included to determine ways other countries might help them to develop indigenous capabilities. This report summarizes results of four areas of investigation: overseas R & D activities of TNCs; pharmaceutical programs in tropical diseases; S & T policies of developing countries; and U.S. response to S & T needs in industrial development of LDCs. The main conclusion is that a limiting factor in the ability of LDCs to absorb help offered by other countries is the state of their indigenous S & T capabilities.

1505 **Problem Assessment of Time-of-Day Electricity Rate Structures;** NSF/PRA-7819570; Boston College, Graduate School of Management; Diffenbach J, Murphy D, Renda A; April 1980; 190 p; NSF Grant No. PRA 7819570; NTIS Order No. PB80-188261/NKS

This study identifies the important long-term, indirect impact issues of time-of-day (TOD) pricing of electricity. It points out the potential for adverse societal consequences in the areas of electricity consumption, capital investment, decentralization of electricity generation, effect on solar energy, and night activity. A number of policy issues were identified dealing with mandatory vs. optional rates, strength of price signals, length of peak periods, revenue determination, speed of implementation, waiver provisions for those subject to pricing disadvantages, policy variations for different classes of customers, and Federal vs. state regulation of TOD standards and rates. This assessment provides a synthesis of findings as well as quantitative analyses of specifics. As the integrating methodology for this study, influence diagrams were chosen. Influence diagrams represent the initial qualitative step toward a more rigorous, intensive investigation of the impact issues by means of systems dynamics methodology. The latter methodology is one of the recommended strategies for further study of these issues. Two supporting methodologies used in this report are limits analysis and the use of compatibility assessment for generating more plausible alternative contextual scenarios which could shape TOD pricing consequences.

1506 **Quality of Worklife Programs: A Preliminary Technology Assessment;** NSF/PRA-7706495; Human Interaction Research Institute; Glaser EM, Greenberg PD; June 1979; 329 p; NSF Grant No. ERS 7706495; NTIS Order No. PB81-125379/NKS

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This study of quality of worklife (QWL) improvement efforts was composed of three major substudies, each with separate but interrelated objectives. A preliminary technology assessment of a small sample of QWL improvement programs in manufacturing plants was conducted to determine their primary and secondary effects and, from this assessment, to synthesize tentative implications for public policy. The perceptions of employees with regard to various aspects of their working and nonworking lives were sampled using questionnaires and individual interviews. Some spouses were interviewed, and "objective" data were collected on a number of dimensions of organizational performance such as absenteeism, work-related accidents, productivity, and grievance rate. The attitudes and roles of labor unions with respect to the development of QWL improvement efforts were characterized. Seventeen union officials from 15 major U.S. unions were interviewed. The role of universities (schools of business and management) in the diffusion of the technology of QWL improvement programming was examined. A survey mailed to 114 leading business and management schools attempted to determine the extent to which QWL concepts, issues, and techniques are being taught; typical curriculum content; program organization and genesis; evidence of utilization; and personal attitudes and perspectives of the respondents. The data gathered during these substudies are reported.

1507 **Science and Technology for Development: Corporate Government Policies and Practices;** NSF/PRA-7721851/1; Fund for Multinational Management Education; Behrman JN, Fischer WA; 1980; 158 p; NSF Grant No. PRA 7721851; NTIS Order No. PB81-146789/NKS

A series of case studies concerning research and development (R&D) activities of five transnational corporations (TNCs) was initiated in 1977. The studies focused on a single product line from each company. Activities were surveyed in the United States and abroad. Instead of updating these studies, it was decided to test whether the results could be generalized. In a new phase involving 58 international companies operating in the United States, Europe, and Japan, the limits of inquiry were broadened. A better understanding of the relationship of science and technology (S&T) policies of developing countries to the R&D of international companies was sought. Nine less-developed countries (LDCs) were included to determine ways other countries might help them to develop indigenous capabilities. This monograph summarizes three of the original studies and presents findings of more recent investigations in the following areas: pharmaceutical programs in tropical diseases; S&T policies of developing countries; and United States response to S&T needs in industrial development of LDCs. The main conclusion is that a limiting factor in the ability of LDCs to absorb help offered by other countries is the state of their indigenous S&T capabilities.

Note: This report is available in microfiche form only.

1508 **Science and Technology Policy: Perspectives for the 1980s (Annals of the New York Academy of Sciences, Volume 334);** NSF/PRA-7909060; New York Academy of Sciences; Fusfeld HI, Haklisch CS; 1979; 394 p; NSF Grant No. PRA 7909060; NTIS Order No. PB81-106098/NKS

This volume is based upon papers and summaries of discussions presented at a conference on March 17 and 18, 1979, at New York University. Leading figures from the developed countries of the world reviewed a wide range of policy issues in science and technology. The experience and judgments of these individuals provided a forum of opinion on three questions: (1) What are the current major issues in science and technology policy? (2) What appear to be the trends, what new problems are anticipated within the next five years, and what new priorities may arise among the present ones? (3) Given the growing experiences and experiments of different countries, what approaches to these issues appear to be effective, and to be recommended for emphasis, for both government and the private sector? The conference focused on the relationship of science and technology to such national concerns as economic growth, the impact of regulation and foreign policy, and to technical fields including energy, materials, and communications. This volume contains the formal papers presented at the plenary sessions, the papers presented at each panel session, and the summaries of the panel discussions with comments by panel chairmen. Since this volume considers current and near-term problems and recommends approaches to solutions, it can provide a reference point for western industrialized countries to develop policy guidelines for improving the health of science and the usefulness of technology.

1509 **Social Beliefs and Social Technical Change: A Case Study and Methods;** NSF/PRA-7624067; Kalba Bowen Associates, Inc.; Clippinger JH, Berk G, Sonnenfeld J, et al; 1979; 524 p; NSF Grant No. ERS 7624067; NTIS Order No. PB81-162216/NKS

This study attempts to provide the theoretical and analytical means to describe technical systems better and to anticipate more effectively their social and cognitive consequences. Three approaches are taken: (1) development of a general framework to classify all types of technical systems in terms of their potential social effects; (2) development of methods to describe the "social beliefs" of groups potentially affected by social technical change; and (3) applications of these methods to a case

study of the social and psychological effects of technological change in northern New England logging practices. The case study is used to illustrate some methods for assessing the social and psychological implications of technological change. Results of 30 open and 51 closed interviews with three types of loggers are presented. Included in the appendices are topics covered in open interviews, core concept definitions, closed questionnaires, and additional results of closed interviews.

1510 **Study of Innovation in Manufacturing: Determinants, Processes, and Methodological Issues, Volume 1, Panel Study of the Determinants of Innovation in the U.S. Footwear Industry;** NSF/PRA-7423652/1; University of Maine at Orono, Social Science Research Institute; Duchesneau TD, Cohn SF, Dutton JE; December 1979; NSF Grant No. RDA 7423652; NTIS Order No. PB81-156739

This report presents the findings of a study of innovation processes in an industrial setting. The goal of the study was to improve the understanding of the processes whereby industrial firms adopt or reject technologically innovative production equipment, the patterns and paths through which such innovations are diffused through an industry, and the factors influencing adoption and diffusion rates. The domestic footwear industry was selected as the major focus of the project because the industry was experiencing an effort to promote innovation and an expanded set of technological opportunities was available. Two basic methodologies used for data collection were a panel study framework and case studies. Volume One presents an empirical test of major hypotheses of innovation from the economic, management, and organization theory research traditions. Expanded models of innovation are developed and tested. Volume Two presents the results of five case studies of innovation decisionmaking. The case studies examine various hypotheses about decisionmaking that could not be adequately addressed with a panel study methodology. The effectiveness of a methodology combining panel and case studies is discussed. NSF has conducted an evaluation of this research product; the summary is appended to this volume.

1511 **Study of Innovation in Manufacturing: Determinants, Processes, and Methodological Issues, Volume 2, Case Studies of Innovation Decision Making in the U.S. Footwear Industry;** NSF/PRA-7423652/2; University of Maine at Orono, Social Science Research Institute; Duchesneau TD, Cohn SF, Dutton JE; January 1979; 178 p; NSF Grant No. RDA 7423652; NTIS Order No. PB81-156747

See Entry 1510 for abstract.

1512 **Study of Innovation in Manufacturing: Determinants, Processes, and Methodological Issues, Executive Summary;** NSF/PRA-7423652/3; University of Maine at Orono, Social Science Research Institute; Duchesneau TD, Cohn SF, Dutton JE; March 1980; 32 p; NSF Grant No. RDA 7423652; NTIS Order No. PB81-156721

See Entry 1510 for abstract.

1513 **Technical Change in the Railroad Industry, Part 1: Piggybacking and Intermodalism, Final Report;** NSF/PRA-7617394/1; Massachusetts Institute of Technology; Friedlaender AF; October 1980; 249 p; NSF Grant No. PRA 7617394; NTIS Order No. PB81-158180/NKS

This report consists of five papers involving technical change in the railroad industry. The papers are concerned mainly with piggybacking and intermodalism, terms used for rail truck movements in which entire truck trailers or truck containers are loaded onto railroad flat cars. Included are the following papers: (1) "The Structure of Technology and Costs of U.S. and Canadian Railroads" examines the question of whether regulation inhibits technological changes in the railroad industry; (2) "Intermodalism and Integrated Transportation Companies in the U.S. and Canada" explores whether intermodal ownership has encouraged the use of intermodal operations in Canada as opposed to the U.S.; (3) "Rate Freedom and Intermodal Usage" compares the pricing structures of intermodal services in Canada and the U.S.; (4) "Piggyback Plans: Costs, Rates, and Profitability" analyzes the profitability of piggyback operations, including peculiarities of such operations; and (5) "Some Observations on Domestic Freight Forwarding in Canada and the U.S., An Hitherto Neglected Component of the Transportation Universe" examines the status of domestic freight forwarding operations in Canada and the U.S. and focuses on similarities and differences.

1514 **Technical Change in the Railroad Industry, Part 2: Unit Trains, Final Report;** NSF/PRA-7617394/2; Massachusetts Institute of Technology; Friedlaender AF; October 1980; 203 p; NSF Grant No. PRA 7617394; NTIS Order No. PB81-158198/NKS

This report consists of four papers involving technical change in the railroad industry, particularly in the use of unit coal trains. Included are the following: (1) "Coal Markets and Rail Utilization in Canada since the National Transportation Act" discusses the export metallurgical coal market, the domestic coking industry, and the thermal coal market; (2) "The Railroad Rate Structure and Service Innovation in the Transportation of Coal" searches for evidence of some causal relationship between rate regulation and service innovation in railroad coal traffic; (3) "The Rate Structure of Unit Coal Trains in the 1970's" suggests that the railroads have not been entirely successful in exploiting their latent monopoly power with respect to Western coal markets and derives a rate model under monopoly conditions; (4) "Railroad Volume Coal Rates, A Review of Litigation Accompanying an Innovative Marketing Strategy" evaluates an hypothesis that a regulated firm, in seeking innovations, is constrained through the regulatory process from maximizing the

benefits it might receive from a freer market environment.

1515 **Technical Change in the Railroad Industry, Executive Summary;** NSF/PRA-7617394/3; Massachusetts Institute of Technology; Friedlaender AF; October 1980; 17 p; NSF Grant No. PRA 7617394; NTIS Order No. PB81-138463/NKS

In this study of technical change in the railroad industry, service innovation, rather than technical innovation, is examined. Service innovation is subject to severe regulatory constraints in contrast to technical innovation which is not particularly subject to such constraints. By studying American and Canadian railroad operations, this project has attempted to isolate the economic and regulatory forces that may have impaded or promoted the utilization of specific innovative services in each country. Research in the following areas is summarized: differences in costs and technology between Canadian and U.S. railroads; the role of integrated transportation companies and rate freedom in utilization of intermodal services; and the role of rate freedom in the utilization of unit trains.

1516 **Technology Assessment for Development;** NSF/PRA-7819648; United Nations; Korn A; 1979; 169 p; NSF Grant No. PRA 7819648; NTIS Order No. PB80-187404/NKS

This United Nations Seminar convened from 30 October to 10 November 1978 at Bangalore, India, consisted of professionals from developed and developing countries active in fields wherein technology assessment is particularly relevant. The attendees were to consider questions relating to policy and to economic, social, cultural, environmental, and other consequences associated with scientific and technological development programs. Consideration of technology assessment as a possible aid to development planning was emphasized. It was hoped that the Seminar would provide a point of view concerning the problems and the effects arising from the introduction of new technologies, be they local innovations or acquisitions from abroad. The 24 papers presented at the Seminar are included in this report. Topics covered include the capabilities of technology assessment; technology assessment in energy systems; advanced technology and development strategy in the Middle East; technology assessment in agriculture; technology assessment as policy analysis; technology assessment to meet user requirements; technology assessment for development in the field of health; the limiting factors of small-scale technology assessment; technology assessment in industry; and a case history of technology transfer, the Spanish experience.

1517 **Technology Assessment in Federal Agencies: 1971-1978;** NSF/PRA-7517449; George Washington University, Program of Policy Studies in Science and Technology; Coates VT; March 1979; 588 p; NSF Grant No. ERS 7517449; NTIS Order No. PB295969/NKS

The focus is on the structures and processes of bureaucratic institutions in both executive and legislative branches, the political environment in which they operate, and the effect of these pressures on the attempt to anticipate and evaluate objectively the impact of technology on society and to make decisions in the public interest. The change in technnology-related decisionmaking in the Federal Government from 1972 to 1977 is described, and the growing use of technology assessment and secondary impact analysis is summarized. The technology assessment program of the National Science Foundation which laid the groundwork for this development is covered, as well as the developments in Federal executive (mission) agencies. The report traces one aspect of decisionmaking, the process of planning, research, development, and evaluation which leads to Federal stimulation, utilization, and/or commercialization of technology. Detailed descriptions of the varying experience of each agency with technology assessment and secondary impact analysis, including the "lessons learned" observations of agency personnel, as well as those of the author, are included. It may help administrators and analysts in each agency to compare their experiences with those of others.

1518 **Technology Assessment of the Fluorocarbon/Ozone Depletion Problem, Final Report;** NSF/PRA-7709248; Systems Control, Inc.; Schainker RB; January 1979; 156 p; NSF Grant No. ERS 7709248; NTIS Order No. PB294927/NKS

This study utilizes a computer-based simulation model to provide insight into the implications of various alternatives open to the policymakers in the light of highly uncertain atmospheric and biological processes. Questions addressed in this study include: (1) What are the physical and economic consequences of alternative control actions? (2) What if the environmental effect is less (or more) severe than currently predicted? (3) What effect does the development of an early warning system based upon the detection of ozone depletion have on the decision process? (4) How does the economic discount rate affect the cost analysis? (5) What is the value of further research and added information? In other words, what is it worth to reduce the uncertainty in each of the important variables? The analysis is based upon a series of mathematical models representing each element of the problem. These mathematical models are described in the report. The models form the basis of the computer-based simulation of the real world which is then used to calculate the physical and economic consequences of selected scenarios. The many parameters that are specified for this computer simulation are discussed: alternative control actions; projected ozone depletion by chloro-

fluorocarbons; detection threshold; discount rate; and chlorofluorocarbon production and release. The effect of control of chlorofluorocarbon emissions by the United States alone was studied.

1519 **Technology Assessment: The Impact of Robots, Final Report;** NSF/PRA-7600637; Eikonix Corporation; Kurlat S. Principal Investigator; September 1979; 261 p; NSF Grant No. ERS 7600637; NTIS Order No. PB80-142268/NKS

Intended to provide a data base for the development of policy options regarding the diffusion of robotics, this study is divided into four phases: surveying and forecasting relevant technology for the development of robots through 1990; examining possible application areas for technological feasibility and significance of impact resulting in the selection of three major areas of application; investigating potential socioeconomic ramifications of each of the three selected application areas; and elucidating policy alternatives influencing robotics development. The three robotic applications considered are the domestic robot, the nuclear reactor robot, and the industrial robot. The study concluded that diffusion of robotics in the application areas selected at a rapid rate is highly unlikely. The technical constraints against a vast change in the scope of robotic capabilities is one reason for the slow diffusion rate. It is felt that diffusion will proceed for the next couple of decades in a manner similar to the diffusion of automation. While national unemployment may not be likely to change because of robotic use, the pattern of employment will probably change due to an increasing emphasis on service-type jobs. Federal actions may be warranted to insure that there are adequate, equitable, and satisfactory means of shifting the employment patterns.

1520 **The Transfer of Technology by Multinational Enterprises: A Summary of Three Studies, Final Report;** NSF/PRA-7419491/1; Harvard University, Graduate School of Business Administration; Stobaugh R, Telesio P; September 1980; 176 p; NSF Grant No. PRA 7419491; NTIS Order No. PB81-158172/NKS

The process of transferring technology across national borders by multinational enterprises is explored. The studies focus on the transfer of manufacturing technology through licensing; the choice of technology in investments in developing countries; and the development of a computer model to optimize foreign investment location and intercompany trade decisions. The first study examines reasons why multinational enterprises license abroad, licensing to supplementary foreign investment, and licensing for reciprocity. Two industries, textile and pulp and paper, were selected for the second study. Research methodology, including alternative technologies and procedures used to determine choices, is discussed. The third study describes the development of a model of international investment planning, presenting both company and government points of view. Findings are summarized for each study. General implications for governments interested in increasing benefits from foreign direct investment and licensing are suggested.

1521 **The Transfer of Technology by Multinational Enterprises: A Summary of Three Studies, Executive Summary;** NSF/PRA-7419491/2; Harvard University, Graduate School of Business Administration; Stobaugh R, Telesio P; September 1980; 19 p; NSF Grant No. PRA 7419491; NTIS Order NO. PB81-159477/NKS

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*Principal Investigator for this NSF supported research project—no individual report author listed.

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1522 **Application of Computer Graphics to Air Quality Data Analysis, Technical Report;** NSF/RA-800156; Meteorology Research, Inc.; Vanderpol AH; February 1980; 82 p; NSF Grant No. PFR 7712487; NTIS Order No. PB81-113623/NKS

The utility of analyzing large scientific data analysis programs on a small computer (HP21MX) was demonstrated by analyses of the European Air Chemistry Network (EACN) acid rain chemistry data with the International Meteorological Institute in Stockholm, Sweden. The analysis focused on understanding and quantifying analytical errors in the data and providing statistics for development of a simple photochemical model. Errors in the data base resulted from the processes of collecting the rain water, analyzing it for ions, and recording the values. A statistical approach was employed to identify and correct errors in the data base. The median values supplied were over several years and stations. The model examined concurrent sulfate and nitrate formation processes during transport from the source of the primary sulfur and nitrogen oxides. The most important tentative conclusion of the model study is that atmospheric sulfate and nitrate formation rates are interdependent and nonlinear, suggesting that the reduction of emissions of either oxides of sulfur and/or nitrogen will not necessarily result in a proportional reduction of the acidity of rain downwind from the sources. Detailed appendices discuss EACN errors, formation of sulfuric and nitric acids, and five computer programs.

1523 **Big Sky Coal Mine—A Mine-Site Study of Benefits and Costs of Reclaiming Surface-Mined Land in the West, Part III;** NSF/RA-790385; Pennsylvania State University, College of Earth and Mineral Sciences; Julian E L; 1979; 202 p; NSF Grant No. APR 7618486; NTIS Order No. PB80-176605/NKS

The benefit-cost ratio of western coal reclamation is examined. Rising prices of imported crude oil have spurred significant expansion of western coal production to increase domestic sources of energy. This in turn has raised concerns about environmental impacts with resultant state laws requiring reclamation of mined land. Standard benefit-cost analysis studies provide insight into the absolute and relative size of benefits and costs of reclaiming surface-mined western coal land using a case study of the Big Sky Mine in southeast Montana. This report presents the project's rationale, problems, and objectives. Several analyses of benefits and costs of reclamation are reviewed. The environment at Big Sky Mine is described, and the laws and regulations affecting the mine are cited. Procedures and costs of reclamation at the mine are discussed, and the valuation methodologies of outdoor recreation and recreational benefits are examined and estimated. Benefits and costs are compared with respect to both priority and social benefits.

1524 **Construction of Pulse Echo Ultrasonic Test Equipment and Acquisition of Tissue Signature Data, Final Report;** NSF/RA-800105; New York Institute of Technology, Science and Technology Research Center; Glenn WE, Rabinowitz JR, Weiss L; 1980; 60 p; NSF Grant No. DAR 7610364; NTIS Order No. PB80-221880/NKS

Work is reported on the design, fabrication, and testing of equipment to measure the interaction of ultrasound with small biological samples under conditions of minimal biological degradation. This equipment has also been used to measure these interaction parameters for various samples of tissue. Velocity, total attenuation, and scattering measurements can be made in rapid succession on a single sample. Absorption measurements require a swept burst of ultrasound over one-third of an octave and small tissue samples; therefore, they cannot be performed rapidly on the same sample. The method used for measuring absorption coefficients is a reverberation technique similar to one used in room acoustics. It calls for two measurements of the reverberation time, one with the chamber containing saline, and the other where some of the saline has been replaced by the tissue sample. The difference between these two measurements yields the rate of decay in the tissue. It appears that the greatest part of the attenuation of ultrasound by tissue is due to scattering, not absorption. Therefore, it should be expected that scattered signals are more likely to give more useful signatures than absorption measurements. The results of studies on tumorogenesis are reported. Also, tissue interactions having diagnostic importance are noted.

1525 **Controlled Microbial Conversion of Poultry Waste into a High Protein Feedstuff, Final Report, May 1, 1976—October 30, 1978;** NSF/RA-790438; Cornell University, Department of Microbiology; Shuler ML, Austic RE, Seeley HW, Jr.; January 1979; 146 p; NSF Grant No. AER 7605681; NTIS Order No. PB80-200884/NKS

This report describes technically feasible one- and two-stage processes for aerobic conversion of poultry manure into high protein feedstuff. These processes increase the efficiency of animal production and minimize the amount of waste matter released to the atmosphere. The two-stage continuous aerobic process begins with degradation of uric acid and release of ammonium ion and continues with the addition of carbon in the form of molasses or glucose to obtain a carbon-to-nitrogen ratio suitable for microbial proliferation. The product consists of a nearly pure culture of Pseudomonas fluorescens which is essentially free of common pathogenic organisms. The single-stage process reduces operational complexity and offers a potential cost reduction by eliminating the second stage by using a mutant of P. fluorescens. This mutant degrades uric acid in the presence of glucose and ammonium ion. The single-

stage system operates at a pH of about 7.5 without pH control, reduces start-up time, retains nitrogen content, and possibly improves culture stability. A detailed preliminary analysis indicates conditions under which the two-stage process is economically attractive. Economic feasibility of the single-stage process awaits nutritional trials of the product.

1526 **Cooling Water Recycle by Softening, Final Report (May 1, 1977—November 1, 1979);** NSF/RA-790434; University of Houston, Cullen College of Engineering; Matson JV; 1979; 60 p; NSF Grant No. ENV 7706504; NTIS Order No. PB80-200959/NKS

Development of a preliminary design methodology for integrating a sidestream softening unit into a cooling water system to achieve zero pollutant discharge is presented. Cooling water discharge is a major environmental problem which the U.S. Environmental Protection Agency (EPA) and Congress aim to eliminate from all industrial facilities within the decade. Current zero blowdown technologies involve sidestream softening (using lime-soda, reverse osmosis, ion exchange, and electrodialysis) in which a sidestream of water from the cooling tower is treated to remove potential scale-forming and corrosive material. Basics of softening and scaling related to the adsorption of silica and the kinetics of high total dissolved solids (TDS) reactions involving calcium, magnesium, and silica are investigated. This information has been used to derive formulas for preliminary design of the sidestream softener of the zero blowdown, open recirculating cooling system. Two major sidestream softener options have been developed whereby pH is controlled by either carbon dioxide or sulfate addition. The procedure applied to a variety of waters in the United States indicates that zero discharge from cooling water systems is feasible for a wide range of water qualities.

1527 **Cypress Wetlands for Water Management, Recycling and Conservation, Fifth and Final Report;** NSF/RA-800138; University of Florida, Center for Wetlands; Odum HT, Ewel KC, Editors; April 1980; 291 p; NSF Grant No. PFR 7706013; NTIS Order No. PB81-102238/NKS

The recycling of treated wastewaters into cypress domes and the response of these ecosystems and natural patterns in control swamps are reviewed. Results indicate that cypress domes are satisfactory landscape units for interfacing the economics of people and nature. This method is preferable to technological treatment because it costs less; it is better than release of wastewaters on uplands because improved filtration exists and less ecosystem exchange is required; and it is preferred to release into open waters because the swamp ecosystem adapts better to high nutrients and low oxygen conditions. Florida is considering this alternative for tertiary treatment and storm runoff on a case-by-case basis. An unexpected outcome is the savings of water from evapotranspiration by upland swamps. Energy evaluations show the swamps to be a major way to both save energy and to use solar energy for fruitful economic purpose, thereby saving waste treatment costs and maintaining a supply of high-quality timber. Smaller projects are described to determine the best loading of wastewater addition to flowing swamps and to test other kinds of wastewater, such as those containing sulfates and those from phosphate mining.

1528 **Evaluation of DASI FreeFallingFilm UHT Milk, Final Report, Volume I: Project Activities;** NSF/RA-790433; DASI Industries, Inc.; Nahra J E, Principal Investigator; October 1979; 61 p; NSF Grant No. AER 7704162; NTIS Order No. PB80-201874/NKS

The objective of this project was to determine nutritional and biochemical data on milk which had been sterilized using the DASI FreeFalling Film ultra-high temperature (UHT) system at the University of Maryland. Such data would be valuable in introducing sterilized milk in the United States and as an energy conservation measure. The DASI unit operates on the principle of heating a free falling film of product by a saturated culinary (pure) steam atmosphere under pressure. Volume 1 presents a summary of scientific findings and a review of papers and presentations that were made to disseminate data developed by the project. In Volume 2, the comprehensive findings of research teams of Ohio State University and the University of Maryland are reported. Protein conformational changes and protein-protein interaction were quantified to determine the percent of denaturation of caseins and serum proteins at various temperatures and holding times. The extent of interaction between serum proteins and casein micelles was quantified. The enzymatic activity of protease, lipase, phosphatase, and xanthine oxidase, including reactivation over a span of time, was measured and quantified. The growth characteristics and final properties of the cultures used to produce yogurt, buttermilk, and cottage cheese were quantified and described.

1529 **Evaluation of DASI FreeFallingFilm UHT Milk, Volume II, Final Report;** NSF/RA-790431; DASI Industries, Inc.; Nahra J E, Principal Investigator; October 1979; 342 p; NSF Grant No. AER 7704162; NTIS Order No. PB81-119125/NKS

See entry 1528 for abstract.

1530 **Evaluation of the Oak Ridge National Laboratory Multiregion Model, Final Report, Volume 2, (August 15, 1977—August 31, 1979);** NSF/RA-790382; Ohio State University, Research Foundation; Fisch O, Gordon S I; August 1979; 127 p; NSF Grant No. ENV 7715020; NTIS Order No. PB80-164841/NKS

MULTIREGION is a population and employment projection model used to project popu-

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lation by age, sex, and employment for 37 economic sectors at 5-year intervals. The geographic breakdown of these projections is the 173 BEA (Bureau of Economic Analysis) economic areas in the United States. This model is reviewed and evaluated both in terms of its theoretical underpinnings and in terms of its empirical operational characteristics: (1) regional models that have been derived in the United States with a similar purpose in mind are presented; (2) model assumptions, inputs, and outputs of MULTIREGION are given and compared to the previous modeling efforts described; (3) operational problems of the MULTIREGION model are delineated; and (4) an empirical test of the accuracy of the MULTIREGION model is presented.

1531 **Evaluation of the Oak Ridge National Laboratory Subregional Land-Use Allocation Model, Final Report, Volume 3 (August 15, 1977—August 31, 1979);** NSF/RA-790383; Ohio State University. Research Foundation; Fisch O, Gordon S I, Sequin J, et al; August 1979; 73 p; NSF Grant No. ENV 7715020; NTIS Order No. PB80-171341/NKS

A subregional model is reviewed in detail as prelude to the applications testing of the model in Ohio. Its purpose is to interface labor supply and demand with industrial level-use allocation. In practice, land use is not considered at all by the model except in implicit terms. Instead, the model allocates labor and population to subregions through the process of adding and removing industrial plants and other activities. The model also calculates the commuting and migration which result from the allocation process. This overview of the theories and ideas behind the model includes the following: (1) a critique of the mathematical representation made of the socioeconomic system by this model; (2) a focus on a series of technical problems in the computer code, documentation, data sources, and availability; and (3) a set of recommendations and conclusions concerning this model and its potential usefulness in Ohio.

1532 **Management of Toxic Materials in Municipal Sludges Symposium, Overview Papers and Summaries of Discussion (Miami, Florida, March 21-23, 1979);** NSF/RA-790408; Environmental Quality Systems, Inc.; Weinberger L; March 1979; 127 p; NSF Grant No. PFR 7815874; NTIS Order No. PB80-170392/NKS

This symposium provided an opportunity for intensive communication and exchange of information among those active in the field of toxic materials in sludge. Four major areas of interest provided the focus: (1) impact of legislation on toxic materials in sludge; (2) toxic pollutant sources; (3) sludge characteristics; and (4) control of toxic materials in sludge. This document presents the four overview papers which correspond to the four interest areas, as well as summaries of the discussions in each task group.

1533 **The Non-Ferrous Mining Industry in the American Southwest, Final Report;** NSF/RA-800172; University of New Mexico, Department of Chemical and Nuclear Engineering, and the Bureau of Business and Economic Research; Mead RW, Bonen GW; July 1980; 284 p; NSF Grant No. AER 7802378; NTIS Order No. PB81-105389/NKS

This study investigates the impact of changing technology on the generation of waterborne and airborne residuals and on the consumption of energy and water. It focused on the copper industry and its principal byproduct, molybdenum. Nearly 85 percent of the domestic production of both metals comes from Arizona, Colorado, New Mexico, and Utah. The technology was studied to develop detailed process information for each existing technology as well as for newly developing technologies. Process information was used to construct a large linear programming model of the industry. The response of the model to various levels of environmental constraint and various prices of water and energy provides data on changes in technology that would occur under various external situations. It was demonstrated that this methodology is capable of providing summaries of detailed technical information for use by policymakers in framing and deciding various legislative and regulatory actions. Additional findings related to pyrometallurgy, hydometallurgy, water recycling, and sulfur dioxide emission prevention are discussed.

1534 **Power Plant Waste Heat Utilization in Aquaculture, Final Report (November 1, 1976—November 1, 1979) Volume 1;** NSF/RA-800187; Public Service Electric and Gas Company; Guerra CR, Godfriaux BL, Eble AF, et al; March 1980; NSF Grant No. ENV 7819854; NTIS Order No. PB81-110785/NKS

A three-year research study on the constructive use of electric generating station waste heat in cooling water effluents for fish production is summarized. The studies were performed at the Mercer Generating Station on the Delaware River in New Jersey. Results of the project indicate not only that it is biologically feasible to rear fresh water shrimp and rainbow trout alternately during warmer and cooler months directly in these effluents, but that it appears to be economically and technically feasible. A prototype commercial waste heat aquaculture facility for the high density culture of both finfish and shellfish is described in a subsequent proof-of-concept study. This volume presents the research objectives, approach, and product use and a technical section outlining the engineering, biological, and economic feasibility as well as product quality. Technical papers in the appendices include "A Method of Maintaining Aquaculture Process Flow During Chlorination of Electric Generating Station Cooling Water" and "Venture Analyses for a Proposed Commercial Waste Heat Aquaculture Facility."

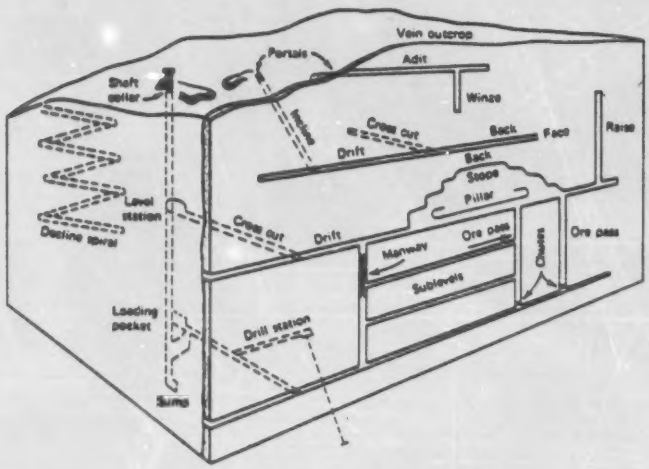

FIGURE 3-4. UNDERGROUND MINING TERMS.

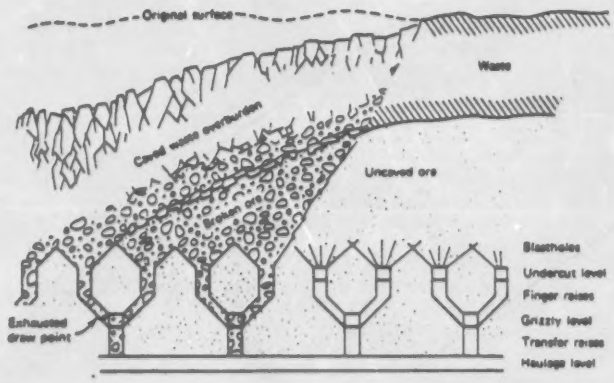

FIGURE 3-5. BLOCK CAVING.

See Entry 1533

RESEARCH PUBLICATIONS FROM PREVIOUSLY SUPPORTED PROGRAMS

1535 **Power Plant Waste Heat Utilization in Aquaculture, Final Report (November 1, 1976—November 1, 1979) Volume 2;** NSF/RA-800188; Trenton State College, Department of Biology; Eble AF; March 1980; 314 p; NSF Grant No. ENV 7619854; NTIS Order No. PB81-110793/NKS

This volume specifically describes that part of the research conducted by Trenton State College. Water temperatures from the discharge canal of the Mercer Generating Station in New Jersey were blended with those from the Delaware River by pumps installed in strategic locations to achieve desired temperatures. The report further describes how recirculation is controlled during chlorination periods by activating and deactivating certain pumps. As a result of this procedure, plus an oxygen injection system, trout density was greatly increased. Techniques for growing and maintaining shrimp larvae and early juveniles in nursery systems are described. Harvest densities of the shellfish did not compare with those obtained for finfish. Although the use of channel catfish to replace tropical prawns as warm water species proved less successful, it was concluded that catfish culture could be improved by instituting a hatchery program. Eel culture at the facility has progressed well. Management techniques are described, including production of eel food, treatment of raceways to prevent disease, and stocking and harvesting procedures.

1536 **Power Plant Waste Heat Utilization in Aquaculture, Final Report (November 1, 1976—November 1, 1979), Volume 3;** NSF/RA-800189; Rutgers University, Center for Coastal and Environmental Studies and Department of Physiology; Farmanfarmian A; March 1980; 133 p; NSF Grant No. ENV 7619854; NTIS Order No. PB81-110801/NKS

This report describes procedures and methods for the commercial culture of the giant fresh water shrimp, Macrobachium rosenbergii and the rainbow trout, Salmo gairdneri in the thermal discharge water of the Mercer Power Plant in Trenton, New Jersey. Discharge water from this plant was used in a preliminary assessment of the survival, growth, and food conversion ratio of these species. It was shown that acute or chronic exposure to power plant intake and discharge water, discharge with or without coal particles, and discharge with or without slurry overflow mix do not significantly affect metabolism, short-term survival, growth, or conversion efficiency of shrimp or trout. Histological examination of shrimp tissue directly exposed to coal microparticles revealed accumulation only in the stomach and intestine. Chlorine from the discharge water had a deleterious effect on the behavior and survival of shrimp and trout. Results are presented of studies which examine the effects of mercury (to simulate coal burning power plant emissions), temperature extremes, dissolved oxygen, amino acids, and calcium on the two species.

1537 **Regulation of the Coal Industry—Health and Safety, Surface Mining and Other Issues, Parts I and II;** NSF/RA-790384; Pennsylvania State University, College of Earth and Mineral Sciences; Gordon R L, Manula C B, Ramani R V; 1979; 703 p; NSF Grant No. APR 7618486; NTIS Order No. PB80-176597/NKS

Efforts to appraise impacts of the Coal Mine Health and Safety Act (CMHSA) of 1949 and surface mining regulations are reviewed. Also, an overview of numerous policies restricting the production and use of coal is presented. The effects of CMHSA on output were appraised by three methods, all of which indicate that CMHSA has reduced productivity significantly and concurrently raised coal mining costs 20 to 30 percent. Regression analyses demonstrate that costs appear to be five to 20 times higher than safety benefits. Data on potential health benefits suggest that they are unlikely to be great enough to raise benefits to equal costs. Hence, CMHSA advocates must show that benefit estimates are seriously understated. Analysis of surface mining regulations demonstrates that unless estimates of aesthetic benefits are grossly underestimated, surface mining reclamation entails costs which far exceed benefits. Global implications of these studies are not easily determined. A simulation study discusses health and safety regulations. A case study of a western strip mine provides extensive data which may or may not be representative. Overall, the conclusion is that the cost effectiveness of surface mining regulations is questionable.

1538 **Three Approaches to Input-Output Modeling in NSF/RANN Regional Environmental Systems Projects, Final Report, Volume 5 (August 15, 1977—August 31, 1979);** NSF/RA-790491; Ohio State University Research Foundation, Department of City and Regional Planning; Fisch O, Gordon SI, Given R, et al; August 1979; 129 p; NSF Grant No. ENV 7715020; NTIS Order No. PB80-210198/NKS

Three projects are analyzed in which current state-of-the-art methodologies are applied to the solution of technical planning problems at state, regional, and local levels. The first project dealt with development of methodology to resolve the economic expansion-environmental dilemma, replacing subjective evaluation with information produced through scientific analysis. The second project concerned regional analysis and management of environmental systems to provide information for making land-use decisions. The third project involved devising a series of models called the Regional Activities Model comprising nine computer programs which calculate economic conditions and predict the residual impacts of economic activities. All three projects utilized Input/Output (I-O) analysis. I-O models are described together with the survey methods used to modify national or state I-O coefficients for use in a region. A detailed review describes each project and the application of I-O. Application of the methodology to Ohio appears limited.

RESEARCH PUBLICATIONS FROM PREVIOUSLY SUPPORTED PROGRAMS

1539 **Value of Time in Environmental Decision Processes, Concepts and Issues, Volume One, Main Report;** NSF/RA-790532; University of Michigan, School of Natural Resources; Schramm G, Andrews RNL, Broder J; et al; November 1979; 150 p; NSF Grant No. ENV 7700351; NTIS Order No. PB81-122137/NKS

An analysis of the nature of time-related costs and benefits is presented. Some of the problems of multi-objective analysis as related to the value of time are discussed: an assessment of the underlying social values that affect environmental controversies; the role of the media in facilitating or hindering environmental decision processes; an analysis of legal factors; and the role of institutions and administrative structures. A case study of the costs of time applied to atomic powerplant licensing processes is presented. Licensing procedures for atomic powerplants are prominently used throughout the study to illustrate the discussions. Findings are summarized and a set of recommendations for future research is proposed.

1540 **Value of Time in Environmental Decision Processes, Concepts and Issues, Volume Two, Annexes I-IV;** NSF/RA-790533; University of Michigan, School of Natural Resources; Schramm G, Andrews RNL, Broder J, et al; November 1979; 227 p; NSF Grant No. ENV 7700351; NTIS Order No. PB81-126435/NKS

Topics covered include social value conflict dimension, legal factors, and organizational and institutional dimensions. Examination of a variety of environmental controversies revealed a complex array of possible reasons for conflict among social, environmental, political, and economic values. These value conflicts result in disruption of the decisionmaking agenda. The terms "agenda expansion" and "agenda constraint" are used in this report to avoid the negative connotations of the term "delay" and to suggest a more complex process. The occurrence of delay, considered as agenda expansion, is better conceived as an opportunity for developing a setting for social learning, for assessing changing conditions, and for searching for new methods and solutions. Delay of environmental decisions is seen as one symptom of a larger problem or condition of changing beliefs and values. Proposed solutions which suggest reducing delay by limiting citizen involvement, restricting official review of projects or decisions, or fortifying and modifying basic design and siting characteristics are not responsive to deeply-rooted value conflicts.

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Appendix A

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28	Automated Information System for Emergency Dispatch	Minneapolis, MN
41	Computer Aided Dispatching of Emergency Vehicles	Lower Merion Twp., PA
52	Emergency Medical Service	Arlington, TX
111	Automated Home Health Billing and Reporting System	Independence, MO
118	Lead Paint Removal	Worcester, MA
141	Cable Television Alarm Service	Syracuse, NY
144	Local Transit System Provides Public Safety Services	Spokane, WA

HUMAN SERVICES

8	Award of Cable Television Franchise	Spokane, WA
62	Retrofitting Existing Housing for Energy Conservation	Pueblo, CO
71	Library Circulation Automation	San Jose, CA
93	Improved Telephone Service	Henrico Co., VA
96	Graffiti Removal Methods	Worcester, MA
111	Automated Home Health Billing and Reporting System	Independence, MO
114	Library Cataloging System	San Jose, CA
118	Lead Paint Removal	Worcester, MA
125	Citizen Survey	Little Rock, AR
140	Paper and People Recycling	Newark, NJ
141	Cable Television Alarm Service	Syracuse, NY
172	Artificial Turf Procurement	Spokane, WA
186	Increasing Transit Ridership	Spokane, WA
188	City Government Television Channel	Spokane, WA
192	Municipal Use of Infrared Thermography	Garland, TX
194	Sprinkler Head Vandalism	Spokane, WA
195	Use of Golf Course for Skiing	Grand Rapids, MI

MANAGEMENT, FINANCE, AND PERSONNEL

1	Planning for Electronic Data Processing Service Delivery	Alexandria, VA
5	Parks Maintenance Management System	Akron, OH
7	Changes in Methods of Police Department Management	Arlington, TX
8	Award of Cable Television Franchise	Spokane, WA
13	Reorganization of Refuse Collection	Little Rock, AR
16	Development of Geographically-Based Information System	Independence, MO
21	Automated Energy Monitoring System	Henrico Co., VA

25	Flying Fire Squads	St. Petersburg, FL
28	Automated Information System for Emergency Dispatch	Minneapolis, MN
37	Financial Management System Plan	Minneapolis, MN
41	Computer Aided Dispatching of Emergency Vehicles	Lower Merion Twp., PA
44	Municipal Utility Billing Frequency	Pasadena, CA
51	Sanitary Landfill Planning	Independence, MO
61	Sanitation Route Balancing	Little Rock, AR
71	Library Circulation Automation	San Jose, CA
88	Productivity Study of Zoo Personnel	Little Rock, AR
92	Refuse Collection System Revision	Lower Merion Twp., PA
93	Improved Telephone Service	Henrico Co., VA
97	Productivity Improvement in Custodial Service	Little Rock, AR
98	Implementation of a City Pager System	Evanston, IL
108	Productivity Improvement	Little Rock, AR
110	Equipment Replacement	Little Rock, AR
111	Automated Home Health Billing and Reporting System	Independence, MO
114	Library Cataloging System	San Jose, CA
119	Court Docket Scheduling	Independence, MO
125	Citizen Survey	Little Rock, AR
127	Fire Station Location Analysis	St. Petersburg, FL
128	Automated Fuel Dispensing System	West Hartford, CT
130	Fire Department Innovation Fund	Eugene, OR
131	A Distributed Data Processing System	San Jose, CA
134	Building Inspection Consolidation	Pasadena, CA
135	Microfiche Fire Dispatching System	Rochester, NY
137	Input Analysis for Annexation	Great Falls, MT
139	Police Fleet Expansion	High Point, NC
151	Energy Management System	Rochester, NY
156	Fee-Structured Sanitary Sewer Rates	Independence, MO
157	Solid Waste Collection and Disposal Revision	Oklahoma City, OK
158	Refuse Collection Routing and Analysis Package	St. Petersburg, FL
161	Refuse Routing Project	Lexington/Fayette, KY
165	Project Management System	Akron, OH
166	Impact Analysis for Community Development	Great Falls, MT
168	Financial Management System	Independence, MO
169	New Budget Preparation Procedure	Independence, MO
170	Grant Management System	Independence, MO
171	Inspections Information System	Minneapolis, MN
172	Artificial Turf Procurement	Spokane, WA
173	Performance Evaluation Program	Lexington/Fayette, KY
174	Employee Development and Merit System	Lexington/Fayette, KY
175	Maintenance Management Program for Parks	Lexington/Fayette, KY
176	Productivity and Performance Training	Lexington/Fayette, KY
177	Performance Monitoring System for Street Maintenance	Arlington, TX
179	Computerized Inventory Control	Arlington, TX
180	Periodic Maintenance System for Stationary Equipment	Arlington, TX
185	Fuel Control Process	Lexington/Fayette, KY
188	City Government Television Channel	Spokane, WA
190	Budget Trend Reporting System	Ft. Collins, CO

PUBLIC WORKS AND PUBLIC UTILITIES

2	Improvement in Boiler Effciency	Jersey City, NJ
4	Energy Conservation Program	Nashville/Davidson,TN
5	Parks Maintenance Management System	Akron, OH

Appendix A

12	Energy Conservation in New Office Building	Henrico Co., VA
13	Reorganization of Refuse Collection	Little Rock, AR
21	Automated Energy Monitoring System	Henrico Co., VA
35	Land Application of Sewage Sludge	High Point, NC
38	Street Lighting Modifications	West Hartford, CT
44	Municipal Utility Billing Frequency	Pasadena, CA
51	Sanitary Landfill Planning	Independence, MO
61	Sanitation Route Balancing	Little Rock, AR
63	Incinerator Replacement by Landfill	Lower Merion Twp., PA
72	Boiler Replacement for Energy Conservation	Jersey City, NJ
76	Energy Conservation Program	Kettering, OH
80	Comprehensive Drainage Plan	Henrico Co., VA
84	Delamping	Jersey City, NJ
85	Radio Communications	Henrico Co., VA
92	Refuse Collection System Revision	Lower Merion Twp., PA
93	Improved Telephone Service	Henrico Co., VA
96	Graffiti Removal Methods	Worcester, MA
97	Productivity Improvement in Custodial Service	Little Rock, AR
98	Implementation of a City Pager System	Evanston, IL
100	Energy Conservation Modifications Program	West Hartford, CT
107	Wetted Salt	Kettering, OH
110	Equipment Replacement	Little Rock, AR
115	Micro-Computers in Traffic Controllers	San Jose, CA
118	Lead Paint Removal	Worcester, MA
123	Energy Conservation in Traffic Signals	Worcester, MA
124	Mobile Cart System for Refuse Collection	High Point, NC
128	Automated Fuel Dispensing System	West Hartford, CT
132	Energy Audit	Little Rock, AR
134	Building Inspection Consolidation	Pasadena, CA
140	Paper and People Recycling	Newark, NJ
145	Energy Conservation at Water Treatment Facilities	Arlington, TX
146	Energy Management Program for Water Distribution System	Great Falls, MT
147	Refuse to Energy Program	Nashville/Davidson, TN
149	Construction of a Resource Recovery Facility	Newark, NJ
150	Street Lamp Conversion	Pasadena, CA
151	Energy Management System	Rochester, NY
152	Conservation Retrofit of City Hall	St. Petersburg, FL
156	Fee Structured Sanitary Sewer Rates	Independence, MO
157	Solid Waste Collection and Disposal Revision	Oklahoma City, OK
158	Refuse Collection Routing and Analysis Package	St. Petersburg, FL
159	Water Purification	Worcester, MA
160	Refuse Truck Tire Failures	Spokane, WA
161	Refuse Routing Project	Lexington/Fayette, KY
165	Project Management System	Akron, OH
172	Artificial Turf Procurement	Spokane, WA
175	Maintenance Management Program for Parks	Lexington/Fayette, KY
177	Performance Monitoring System for Street Maintenance	Arlington, TX
179	Computerized Inventory Control	Arlington, TX
180	Periodic Maintenence System for Stationary Equipment	Arlington, TX
181	Portable Asphalt Recycling Plant	Spokane, WA
182	Asphalt Recycling	Syracuse, NY
183	Snow and Ice Control Program	Syracuse, NY
184	Oil Additive Reduces Bus Maintenance Costs	Spokane, WA
185	Fuel Control Process	Lexington/Fayette, KY

187	Electrical Power Conservation Study for the Sewage Pumping System	Lower Merion Twp., PA
192	Municipal Use of Infrared Thermography	Garland, TX
194	Sprinkler Head Vandalism	Spokane, WA

TRANSPORTATION

107	Wetted Salt	Kettering, OH
115	Micro-Computers in Traffic Controllers	San Jose, CA
123	Energy Conservation in Traffic Signals	Worcester, MA
128	Automated Fuel Dispensing System	West Hartford, CT
136	Downtown Free Parking	Eugene, OR
139	Police Fleet Expansion	High Point, NC
144	Local Transit System Provides Public Safety Services	Spokane, WA
160	Refuse Truck Tire Failure	Spokane, WA
177	Performance Monitoring System for Street Maintenance	Arlington, TX
182	Asphalt Recycling	Syracuse, NY
183	Snow and Ice Control Program	Syracuse, NY
184	Oil Additive Reduces Bus Maintenance Cost	Spokane, WA
185	Fuel Control Process	Lexington/Fayette, KY
186	Increasing Transit Ridership	Spokane, WA

Appendix B

NISEE
PRICE LIST
(This Price List Supercedes All Previous Lists)
APRIL 1981

Program Name	Program Number	Machine Version	Within USA		Outside USA	
			User Guide	Program Pkg	User Guide	Program Pkg
ACE	46-1178	C	$12.	$200.	$25.	$300.
ADAP	16-1273	C	$12.	$300.	$25.	$400.
ANSR I	32-976	C	$25.	$300.	$35.	$400.
INEL2-3	53-1179	C	$5.	$100.	$15.	$200.
APOLLO	50-1078	C	$6.	$100.	$20.	$200.
ASHSD 2	25-975	C,I	$15.	$300.	$25.	$400.
CAL	37-1178	C,I	$6.	$200.	$20.	$300.
CHARSOIL	19-674	C	$5.	$100.	$5.	$150.
CUMLIQ	20-674	C	$5.	$100.	$5.	$150.
DAEM	31-976	C	$7.	$150.	$20.	$200.
DOT/DETECT	33-976	C,I	$10.	$250.	$25.	$300.
DRAIN 2D	14-875	C,I	$25.	$300.	$40.	$400.
EL9 & EL10	49-479	C	$8.	$100.	$20.	$150.
ERTABS	36-677	C	$10.	$250.	$20.	$300.
EAD	01-573	C	$7.	$100.	$20.	$150.
EADHI	13-873	C	$7.	$200.	$20.	$250.
EATSW	17-274	C	$12.	$200.	$25.	$250.
EMOI	34-477	C	$5.	$150.	$15.	$200.
EQRISK	43-1277	C	$7.	$100.	$20.	$150.
ETABS	24-675	C,I	$8.	$200.	$20.	$300.
EXCEMTANK	28-476	C	$7.	$150.	$20.	$200.
EXDOMTANK	55-880	C	$10.	$250.	$20.	$350.
FIRES-T3	52-979	C	$12.	$200.	$25.	$300.
FTAP	47-379	C,I	$8.	$200.	$25.	$300.
GADFLEA	44-678	C	$5.	$100.	$15.	$150.

C - CDC 6400 I - IBM 370

Note: All prices include shipping unless special processing is required.
ALL PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

Appendix B

Program Name	Program Number	Machine Version	Within USA		Outside USA	
			User Guide	Program Pkg	User Guide	Program Pkg
HYPAM	61-1280	C	$15.	$150.	$25.	$250.
LASS 2	40-1077	C	$8.	$200.	$20.	$300.
LASS III	54-780	C	$10.	$200.	$20.	$300.
LAYER	22-275	C	$5.	$100.	$15.	$150.
LUSH 2	21-874	C	$6.	$300.	$20.	$400.
MASH	51-879	C	$7.	$250.	$20.	$350.
NONSAP	18-474	C,I	$25.	$300.	$40.	$400.
PSEQGN	5-0573	C	$7.	$100.	$20.	$150.
QUAD 4	15-1073	C,I	$5.	$150.	$20.	$250.
RCCOLA	45-578	C	$7.	$200.	$20.	$300.
SAKE	23-375	C	$10.	$150.	$20.	$250.
SAP IV	11-474	C,I	$7.	$300.	$20.	$400.
SEAWAVE	30-976	C	$5.	$100.	$15.	$150.
SHAKE	12-773	C	$7.	$200.	$20.	$250.
SHOCHU	42-1277	C	$7.	$100.	$20.	$150.
SHORE 2	26-1175	C	$5.	$200.	$15.	$300.
SHORE III	41-480	I	$10.	$250.	$20.	$350.
SIMQKE	39-777	C	[illegible]	$100.	$20.	$150.
SOLID SAP	2-0573	C	$7.	$250.	$20.	$300.
SPECEQ/UQ	08-573	C	$7.	$100.	$20.	$150.
SPECTR	06-573	C	$5.	$100.	$5.	$150.
STABL	27-[illegible]	C	$25.	$300.	$40.	$400.
SUBWALL	35-577	C	$5.	$200.	$15.	$300.
TABS 77	04-177	C,I	$12.	$200.	$25.	$300.
TABS 80	56-880	C	$25.	$300.	$35.	$400.
TANKFREQ	29-576	C	$5.	$150.	$15.	$200.
TIMES	48-177	C,I	$8.	$200.	$25.	$300.
ULARC	07-573	C	$5.	$100.	$5.	$150.

C - CDC 6400 I - IBM 370

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Appendix B

NISEE / COMPUTER APPLICATIONS

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		TOTAL	

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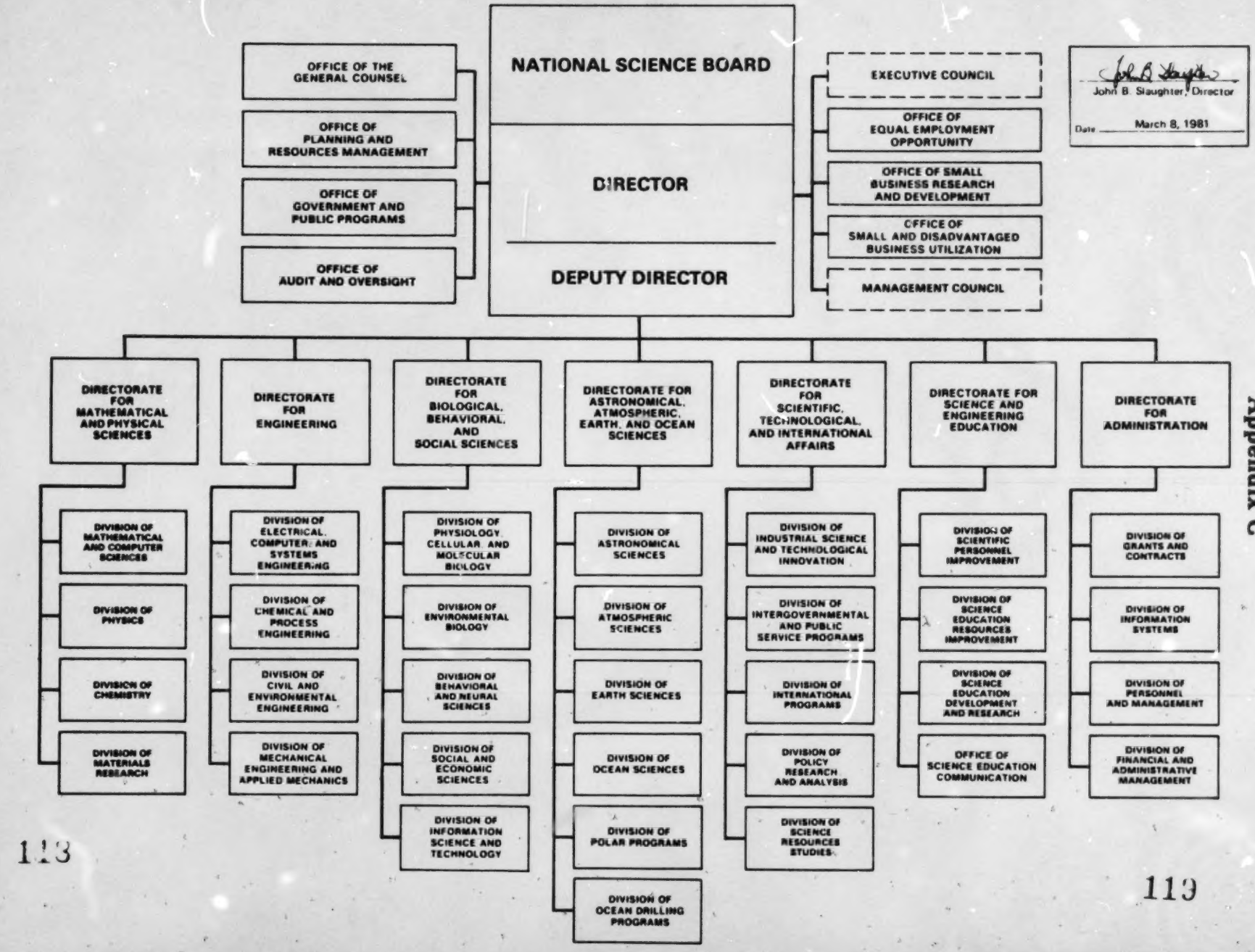
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Appendix C

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